System Design Project

Project plan

RoboTour

Group 18
Mariyana Cholakova
Michal Dauenhauer
Mahbub Iftekhar
Deividas Lavrik
David Speers
Alice Wu
Finn Zhan Chen

1.0 Introduction

Team RoboTour aims to develop a robotic tour guide system *RoboTour* that will assist people in environments such as museums or art galleries. This document describes the project plan and summary, outlining main features of the system, motivation behind it and the team’s general vision of the finished prototype. The plan focuses on processes and timelines that will be used to develop the system, identifying relevant milestones, risks and resources that are allocated to achieve the end goal.

2.0 Concept and Goals

RoboTour is a multi-purpose assistive robot tailored to museum visitors. RoboTour’s mission is to provide a truly immersive cultural experience for underserved visitors by increasing inclusivity through robot guiding assistance and elimination of language barriers.

2.1 RoboTour Specification

The system provides 4 key features to enhance the users experience:

1. RoboTour has multi-language support in Human-Robot Interaction via speech and app
2. RoboTour guides visitors to a specific art piece and points it out to the user
3. RoboTour plays audio description of art pieces in the language the user selected
4. RoboTour provides recommendations and optimal route planning

2.2 User Interface

Visitors can interact with the robot via an Android app via touchscreen and voice. The advantage of using an Android app is that most people would have a phone and existing speech recognition API from Google allows speech interaction between visitors and robots. User Interface prototype can be seen in Fig. 1(a-c)

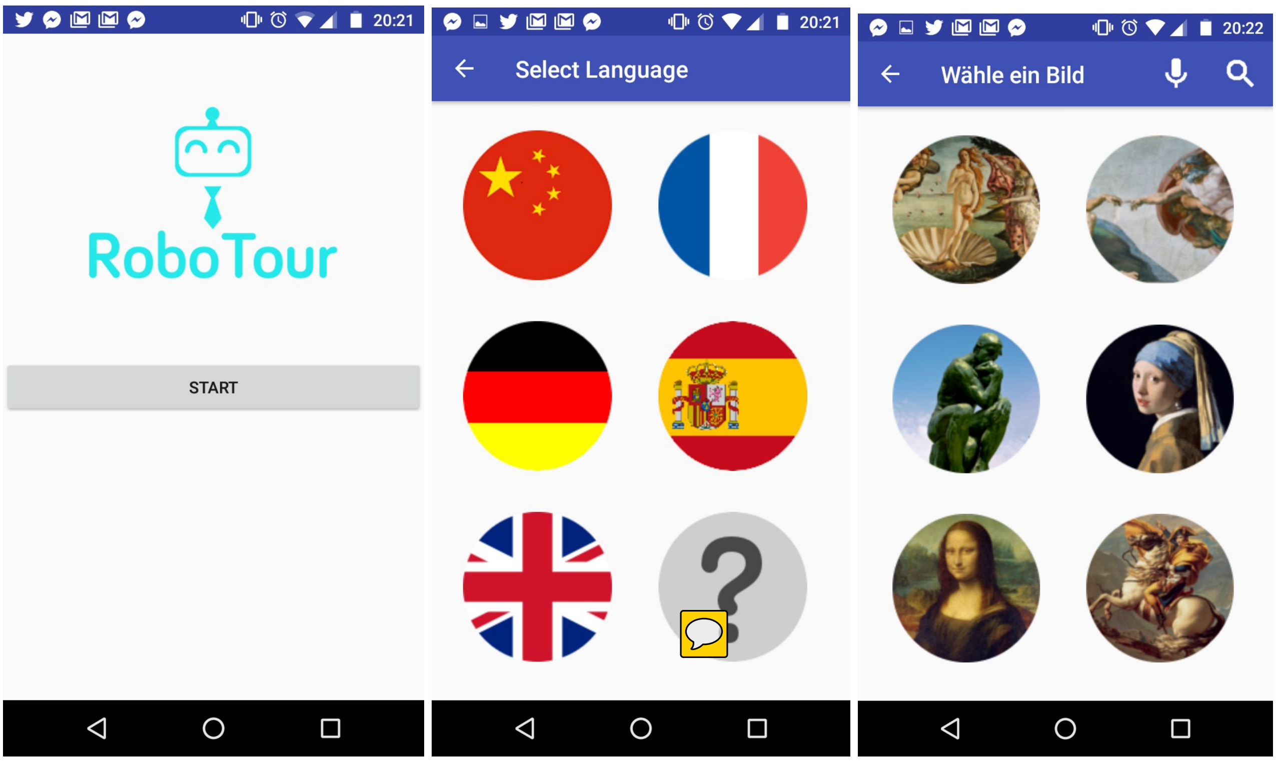

Fig 1a: Home Screen Fig 1b: Language Select Fig 1c: Picture Selection

2.3 Marketing: Market, User & Solution

Beachhead strategy is adopted so RoboTour can concentrate on winning the market of one country before looking into other countries. UK museum is RoboTour's beachhead market because of 2 key reasons: easier to carry out primary research, and personal experience with the user problems outlined next.

2.3.1 Beachhead Target Market: UK Museums

RoboTour's target markets are UK museums which are looking to improve visitor experience and increase revenue from underserved customer segments by providing a truly immersive cultural experience using assistive robotics technologies.

2.3.2 Target User 1 - Visitors with Language Barriers

Problem: UK museums have limited languages offering and are mostly dominated by English so visitors with no or limited fluency in the languages offered by museums are underserved, and thus cannot enjoy cultural immersion extensively.

Evidence: According to Fig 1, around 50% of annual museum visitors are from overseas. Based on primary observations, approximately 40% of them come from countries where English is not the main language and many have limited or no english fluency.

Solution: RoboTour's feature 1 and 3 from section 2.1.

Value Proposition - Revenue Increase:

1. Better cultural immersion for overseas visitor
2. Attracts new overseas visitor
3. Increased customer retention rate
4. Improved visitor experience and increased likelihood to spend

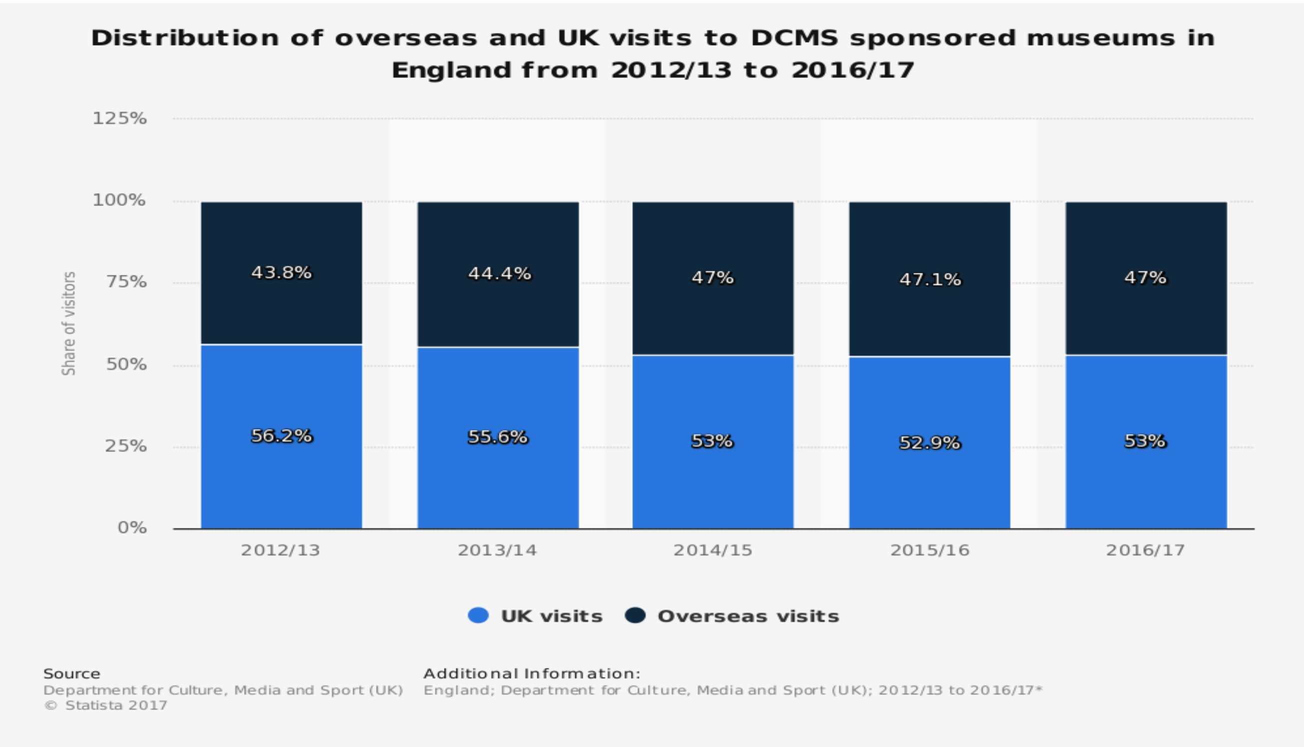

Fig 2: Distribution of overseas and UK visits to Museums in England.

2.3.3 Target User 2 - Visitors who require directional assistance

Problem: With the constant changing dynamics of art pieces in museums and limited staff training, staff members in large museums often do not know where a specific art piece is. Therefore, visitors struggle to visit all art pieces of interest effectively under time constraints, thus leading to lower visitor satisfaction and missing out on some art pieces. RoboTour provides user a personalised experience so they can visit the art pieces they wish to visit, thus optimising their scarce time.

Evidence: Based on primary research, the majority of visitors do not know where an art piece of their interest is located in the museum. Under these circumstances, visitors would consult leaflet maps or staff members.

Solution: RoboTour's feature 2 and 4 from section 2.1. According to Fig 3, speech recognition is regularly used for 3 main common tasks: finding information on a product, asking questions and asking for directions. This justifies why RoboTour is a speech-enabled assistive robot.

Value Proposition - Cost Reduction:

1. Lower staffing cost in terms of headcount and training.
2. Lower time costs for visitors due to improved museum visitors traffic flow (optimal route planning)

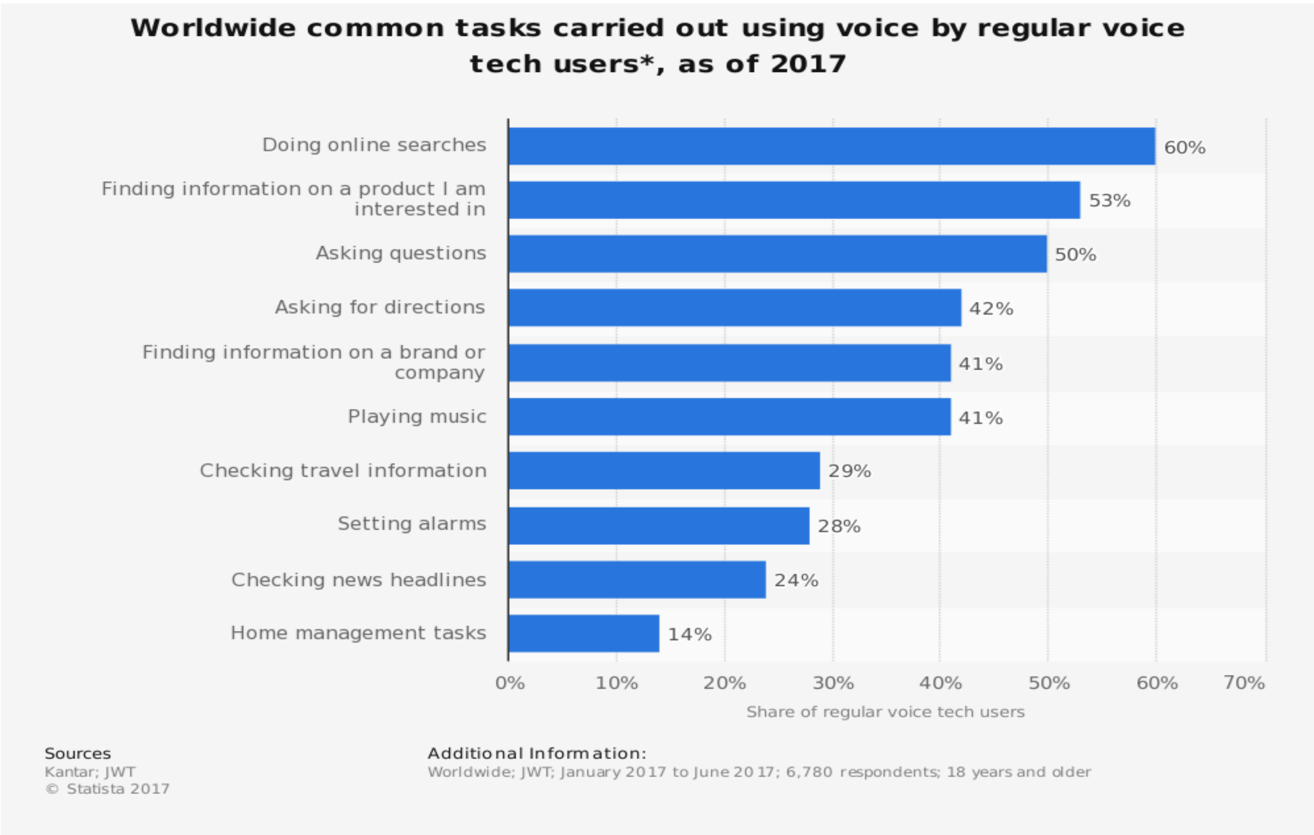

Fig 3: Most common tasks carried out using voice recognition (e.g. Google Assistant and Siri)

2.4 Physical Mockup

The mockup of the prototype's hardware setup is presented in Fig. 4(a-c). The robot will feature a differential drive-base, a suite of environmental sensors and a motorised pointer to perform its designed actions.

Fig 4a: Top View

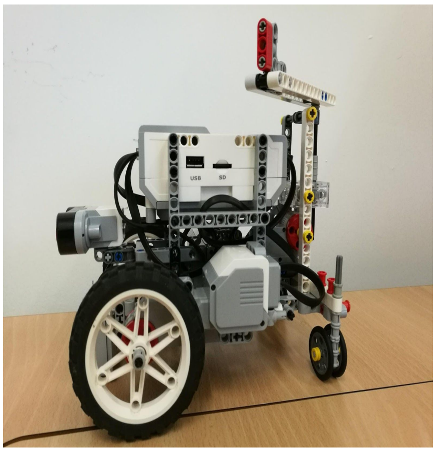

Fig 4b: Side View

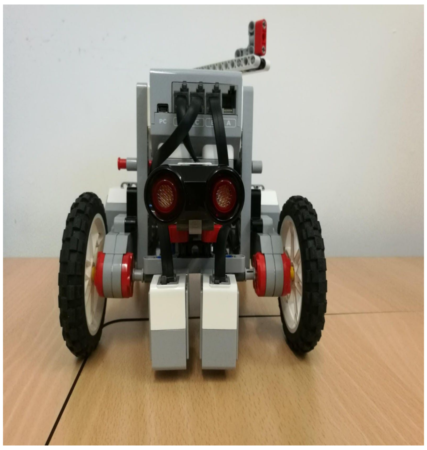

Fig 4c: Front View

3.0 Time Planning

3.1 Technical Milestones for Client Demo

3.1.1 Client Demo 1 - 07/02/2018

Technical Achievement	Evidence
Basic robot built	Can show client robot with bare features: Infrared sensors, 2 color sensors, 3 motors, 4 wheels (2 motorized and 2 for stability)
Robot - app communication functional	The robot can follow simple commands (i.e. move forward, move backwards etc.) issued from the app
User Interface completed	The user is able to interact with an image-driven application using touchscreen.
Basic collision avoidance	The robot passively avoids collisions by stopping in front of detected objects.

3.1.2 Client Demo 2 - 28/02/2018

Technical Achievement	Evidence
Following line paths	The robot can navigate static branching line paths so that it reaches predetermined destination.
Basic Speech Commands	The user can interact with the robot through the app via English speech. The user can send basic commands to the robot. E.g., the user can ask the robot to "Take me to X".
Dynamic collision avoidance	The robot actively avoids collisions by maintaining a safe distance from the obstacle

3.1.3 Client Demo 3 - 14/03/2018

Technical Achievement	Evidence
Speed Adjustment / Variable Speed	Allows the user to specify the speed for the tour or guidance.
Dynamic collision avoidance and navigation	Moving around objects blocking preferred path by calculating a secondary route by using the second line. Robot will be able to plan an optimal route.
Improved User Interface	Allows the user to ask the robot for recommendations via text or speech.

3.1.4 Final Client Demo - 05/04/2018

Technical Achievement	Evidence
Stability	We will demonstrate to the client how the robot has achieved our set goals reliably from previous demos and per the specification.
Polish	We will improve on any features from previous demos that needed polish or enhancement. We will show our improved UI to the client, which will be designed to be more user-friendly compared to previous versions.

3.2 Resource Deployment (200 hours/member)

We aim to use the 200 hours per member as efficiently as possible. Below is the detailed anticipated usage of the time per group member to achieve our goals.

This is a guide to how time will be distributed amongst different tasks for each member. Although this may change e.g. If a member is on the hardware side, they may spend more time on the robot and less time coding and vise versa.

Task	Approx time in hours
Guest lectures	6
Demonstrations	4
Group meetings (incl expected extra meetings)	25
Planning and Admin	40
Debugging & Testing	30
Code Reviews	10
Robot construction	10
Code development	75

3.3 Team Strengths

We have allocated tasks per team members based on their strengths - this is to enable us to use our resources efficiently.

Name	Technical Strengths
Michal Dauenhauer	Electronic circuits design and assembly, embedded programming, mobile robotics
Mahbub Iftekhar	Project management, Java, Kotlin, Android Development, C++, Databases, Networking, Hardware debugging
Deividas Lavrik	Java, Python, C++, Networking, Algorithms and Data Structures, LEGO
David Speers	Java, Kotlin (+Anko), Android Development, Python (+ Numpy, Pandas, matplotlib
Alice Wu	Java, Android Development, Databases, Networking, Algorithms and Data Structures
Finn Zhan Chen	Speech processing, Marketing, Market Research, Pitch making, Android development, Python, Java
Mariyana Cholakova	Java, Python, Android Development, Research

3.4 How will you set up a space on level 3 to demonstrate

We plan to set up mock corridors using the existing layout at the back of the large lab as a demonstration area with minor modifications such as attaching mock artwork for the robot to navigate to. There will be system of lines on the ground for the robot to navigate around the demonstration area.

3.5 Delegation and Volunteering

We have been allocating jobs on a skills basis. It is allowed for members to volunteer to do tasks they feel comfortable doing. If volunteers are not found the group leader will allocate roles based on the strengths of the team in order to optimally allocate resources.

4.0 Dependencies and Risks

4.1 Gantt Chart

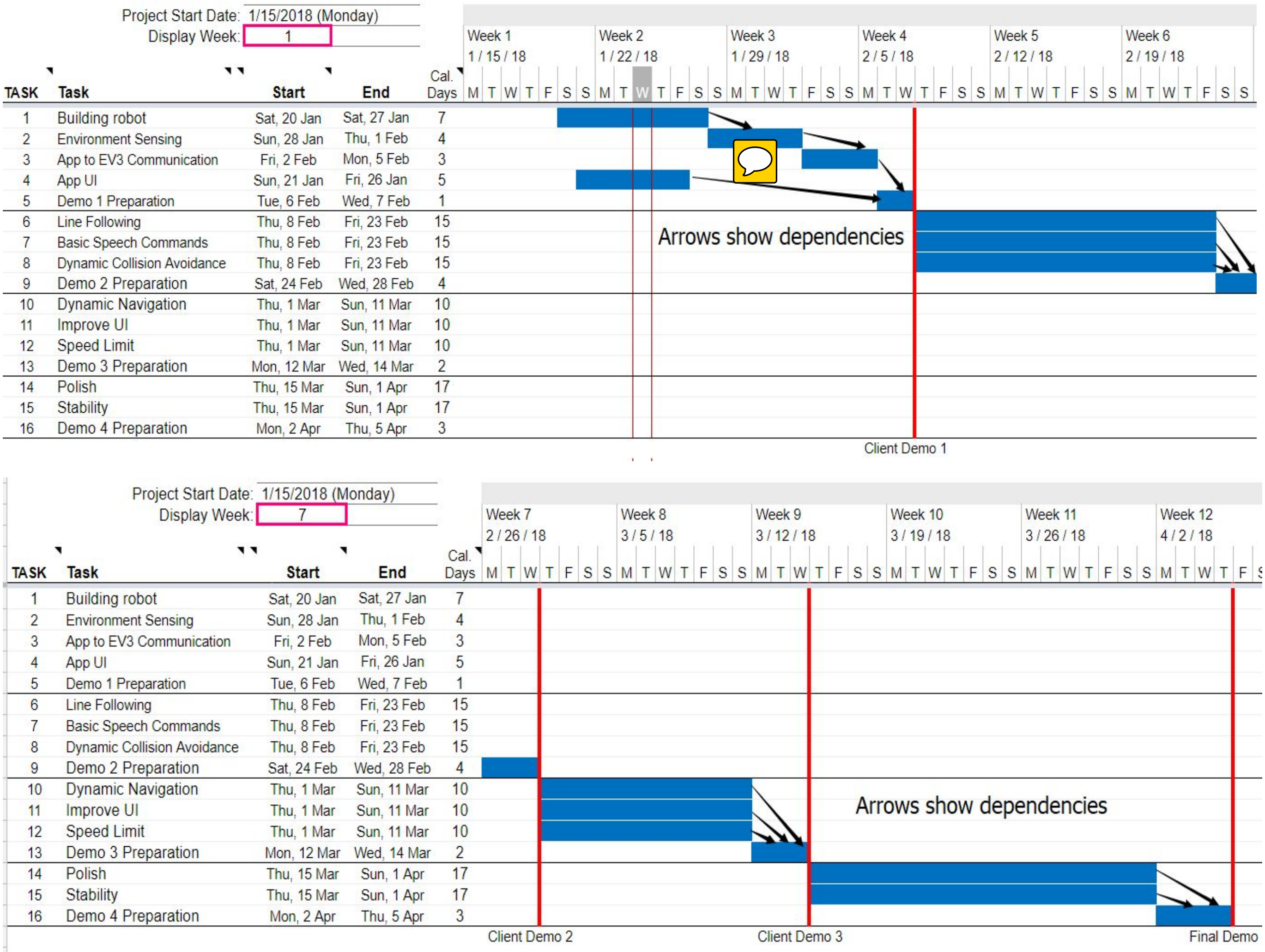

Fig 5: Project Gantt Chart with dependencies and Client Demos identified

4.2 Prototype Constraints

- The prototype robot can only follow lines on the ground.
- It requires that the paintings locations don't change
- The robot will be small at this stage
- If there are obstructions on both lines the robot will not be able to continue.

4.3 Human Risks

4.3.1 Differing Opinions

This will be decided by group voting. In cases when someone has a strong opinion about the direction of the project, he will be encouraged to express his concerns and the team will reconsider.

4.3.2. Not Meeting Deadlines

Internal deadlines are set before the final deadline to ensure highest quality of work. In cases where a team member has other priorities, he is encouraged to notify the team at least 1 week in advance so human resources are reallocated to make sure the deadlines are met.

4.3.3 Illness

If anyone is ill and feels that they will not be able to stick to their deadline, they are responsible for alerting the team leader in order for appropriate action to be taken by the rest of the team to help them meet the deadline. Currently Mariyana is not here, we are in contact with Mariyana, but we do not know when she will be back in Edinburgh, hence we are allocating her tasks which could be done in her absence, so the deadline could still be met. When Mariyana is back, we will explain to her what she has missed.

4.4 Technical Risks

4.4.1 Feasibility

If we discover the agreed features contain subparts which are not feasible given the technical ability and equipment available (within budget), we will try to implement the original features outlined in section 2 by replacing subparts with simpler alternative approach.

4.4.2 Losing The Path

RobotTour might move off track and lose its direction. RoboTour will sound a alarm and ask user to place it back to the path.

5.0 Organisational Structure

Manager & Admin:	Mahbub
Marketing:	Finn (Lead), Mariyana
App:	David (Lead), Mahbub, Alice, Finn
Software Robot:	Michal (Lead), Finn, Michal, Devidas, Alice, Mariyana, Mahbub
Hardware Robot:	Devidas (Lead), Mahbub, Michal

5.1 Task Allocation

Task	Technologies	Members
Building Robot	Python, Electronic circuits, LEGO	Mahbub, Deividas, Michal
Environment Sensing	Python	Deividas, Michal, Mariyana
App to EV3 Communication	Python, Networking	Mahbub, Finn
App UI	Kotlin, Android development	David, Alice
Line Following	Python	Michal, Deividas, Mariyana
Basic Speech Commands	Java, Speech processing	Finn, Mahbub
Dynamic Collision Avoidance	LEGO	David, Alice
Dynamic Navigation	LEGO	Finn, Mahbub, David, Alice
Improve UI	Java, Android development	David, Alice
Speed Limit	Python	Michal, Deividas, Mariyana
Polish	All Above Technologies	Deividas, Michal, Mahbub
Stability	All Above Technologies	Finn, David, Alice, Mariyana

5.2 Meetings

We organized meetings at least once per week to discuss the current progress and the next target. Additionally, we have meetings with the mentor and the manager. Meeting notes where processes, key messages and targets are recorded and is properly formatted for easy retrieval in Google Drive.

5.3 Communications

We are using Slack for task discussion, Messenger for other discussions and using emails to contact mentor and client. Trello is the main tools for our team to manage the task. Tasks in Trello's board are displayed as cards, and each card is assigned to groups such as "to discuss" and "To do". In this case, each team member can find the task quickly.

5.4 Code/File-Sharing

GitHub is the main version control tool for our team to share code. Files are saved and shared on private Google Drive. This is to allow multiple members of the group to work on the same document at the same time, maximizing efficiency.

5.5 Progress Monitoring/Tracking

The manager assigns tasks and ensures meeting deadlines, and asks for progress update at weekly meetings. Each team member is encouraged to notify the team if they run into significant obstacles.

5.6 Development Approach

We are using Agile software development methodology. After each client demo, RoboTour will be improved according to our client's feedback and additional features may be incorporated and so the technical features are subject to change.