Product: DeliverED Home

Team: DeliverED

Abstract

This product aims to provide a convenient and safe way to accept deliveries while out of the house or contactlessly. For this demo, we have made advances in 4 areas: front-end design, app functionality, Webots design and market research. We have conceptualised a first draft of the front-end design - and settled on the core functionalities - of our companion Android application. Secondly, for the website, we have decided on its structure and content with some preliminary mockups for aesthetic ideas. Furthermore, the basic framework of our product has been rendered in Webots. In terms of the movable platform, to be implemented so that parcels are safely lowered, we have considered two options, one being the scissor lift and the other is a motorised platform. Finally, we finalised our market research and have created a questionnaire ready to be distributed. In this document, we have provided the sketches and mockups of the mobile app and website, diagrams of the app and website structure and pictures of the Webots model.

1. Project plan update

Our Demo 1 goals are as follows:

- Design App UI - Achieved
- Market Research - Achieved
- Basic Webots Simulation - Achieved
- Design Hardware Model for Review - Achieved

There was a discrepancy in our initial project plan which should be noted. Our milestones stated that the App UI would be completed during demo 1, and the Website UI would be completed during demo 2. However, our Gantt chart stated that the Website UI would be completed during demo 1, and did not mention the App UI. In practise, we followed the milestones, and completed the App UI, though we also took the initiative and started working on the Website UI.

Our group was split into different teams – the Design team (Amy, Chris, Huacheng), Software team (Harry, Hallelujah, Yizhuo), and Hardware team (Neo, Hrichika). The Design team created the App UI and Website UI, and communicated closely with Harry to get an idea of which functionalities were possible and which were not. Hallelujah created use case diagrams and an app specification document to be used in demo 2 for app implementation. The hardware team created our basic Webots simulation, with Neo rendering the main infrastructure based on Chris's initial blueprint. This blueprint acted as the hardware model which we sent for review. Neo also worked on creating a questionnaire for market research, and Hrichika was in close contact with Gary on the specifics of using a scissor lift for our design, as well as budgeting. During this week we have been managing our tasks using Trello, and have kept in constant contact through Microsoft Teams chat. During the week, the sub-teams met for their specific tasks, and we had a whole group meeting on Friday to discuss our plans for presenting the demo, and to make sure every goal had been met.

Neo has also conducted a market research by using a questionnaire[1] of 8 questions during this week. The survey is composed with respect to data ethics, including informed consent and confidentiality. We've collected around 51 answers so far, and which demonstrates the potential of our product in the market. To sum up, a majority of the answers indicates favour of our product after descriptions given.

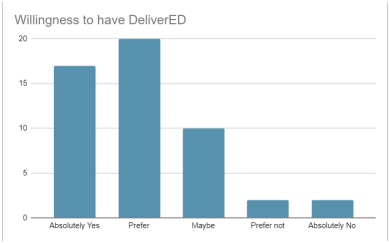

Figure 1. Willingness to have DeliverED

In terms of budgeting, nothing has been spent at this stage, though we have been in contact with Garry about hypothetical costs of the hardware aspects, such as the scissor lift.

Our Demo 2 goals remain unchanged, excluding the fact that designing the Website UI is already partly completed, and for hardware, we are also considering swapping out the scissor lift for using rotational motors to achieve a movable platform. Overall, we are just a bit ahead of schedule.

2. Technical details

2.1. Hardware

In the first week, we've discussed hardware capabilities with technicians. Restricted by current situation, we de-

cided to move into a full simulation in Webot. Thus, we currently don't have any design with PCB or circuit. This week, we've designed a CAD blueprint, and then rendered a rough 3d model in blender and imported into Webot for future programming.

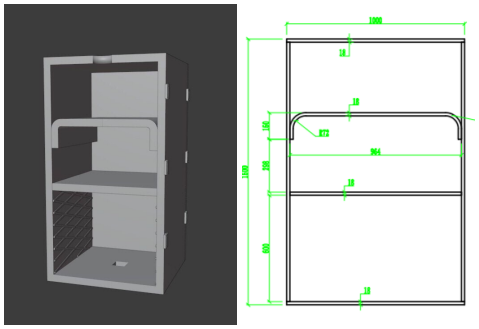

Figure 2. 3d front (Left) Blueprint front (Right)

At the very top it contains a camera recording people who interacts with our mailbox, the top compartment is the entry of parcels, then the collapsible door separating the top and the lower, secure compartment, which will release the parcel gradually to the platform beneath it. The lower side of the collapsible door contains 2 UV sterilizer LED to sanitize parcels. Once the parcel has been dropped onto the movable platform, the platform will lower itself to allow the collapsible door to close. This will avoid parcels from falling straight to the bottom and getting damaged. We are planning on adding an infra-red sensor to sense if the parcel has moved down far enough to allow the collapsible door to close. At the very bottom it contains a slot for installing a Particle Photon as the controller of the mailbox.

To implement the movable platform, we had initially considered working with a scissor lift. The option available to us was a scissor lift which would be approximately 12 inches at its highest, and 6 inches when folded. Even though this would only have been a prototype, we realised that we did not want to sacrifice 6 inches worth of space in our mailbox. Also, the cost for our scissor lift alone would come out to be £70.06. The cost had to be considered since we aim to provide our product at a competitive price, and we aim to keep our pricing within £150. Hence we are considering working with a motor lift, that has two rotational motors attached to the two ends of the movable platform and they are able to move the platform vertically, along the walls of our mailbox.

The mailbox has 2 opening doors controlled by magnetic door releases. The door at the top can be opened by delivery staff. The door at the bottom can be opened only by users to collect the parcels. Once delivery staff put in the parcel, it will pass the one-way collapsible door to the locked compartment below and be protected. In addition, we added another seal for UV sterilizer which is permanently locked in case anyone accidentally be harmed by UV light. We've also added a door at the back of the mailbox for maintenance purposes.

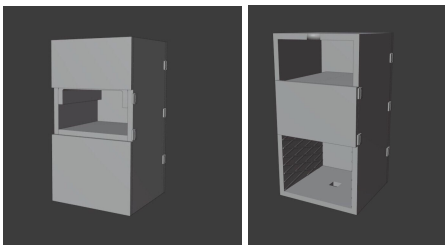

Figure 3. Opening Doors (Left) UVA Seal (Right)

2.2. User interface

The Android application user interface can be seen in Figure 9. This is a complete mockup of the first revision of our design. Functionality and navigation should be finalised, which can be seen in Figure 6.

When the user first launches the application, they are brought to the log in/sign up screen. Once they have accessed their account, they will be brought to the device manager screen - this will be the default screen as it holds the core functions to interact with the smart mailbox. At the bottom of the screen, bar the setting up a device, have a sticky navigation bar at the bottom. On the bar are buttons to the device manager, notifications and user profile. These will be the most accessed screens so they should be available at all times. On the notifications screen the user can see all updates received from the devices, or they can access a single device's notifications from the device manager. The user profile screen contains some info gathered from their Google account and the option to edit them or to log out. Tucked in the side menu of the app are buttons to get in contact, read the user guide and find out more about our product and team. In the same light as the navigation bar, we feel these resources should be able to be accessed from any screen. We kept in contact with the software engineers for the application during our design process to ensure what we envisioned was feasible. During implementation, aesthetics will probably change and evolve as we learn to use the software and to improve the user experience.

The website user interface for a desktop can be seen in figure 8. This is a preliminary mockup of how we could design our product's website. The website structure can be seen in Figure 7. The website UI was not a milestone, but was mistakenly added to the Gantt chart, so we took the initiative to start work on it. It will be completed for Demo 2 as discussed in our project plan.

The website follows a non-linear page structure with a landing page that will introduce what DeliverED and DeliverED Home are. All pages can be accessed from a sticky header - the 'User Guide' is an accented button since that page will be accessed often so should be easy to find.

Aesthetically for all our designs, we chose blue as our primary colour, accented with green and magenta - green and magenta being analogous to blue. We kept the colour palette simple as we feel this should reflect the simplicity

of our user experience. The colour blue symbolises trust and security and green symbolises health and success.

2.3. Software

Our goal for this demo in the area of software was to design the app's layout and functionality as well as discuss some of the technical specifications. Since it is so early in the project, we have not written any code yet, but instead we have focused on having a solid plan. We have set up a Github page to use for the application, and all software-oriented members have downloaded and begun to familiarise themselves with Android Studio. The group decided to use Kotlin as our language of choice for the app rather than Android Java as it is a more modern and concise in terms of syntax. Kotlin is the preferred language of Android developers since 2019, and the team is confident in our ability to learn its differences to Java and utilise it to its fullest extent.

In terms of design and layout, the software and design teams have been in close contact discussing various ideas for the UI of the app. We want the app to be simple to use for all ages and levels of experience, with clear indications of where each section of functionality lies. The app consists of three main pages – a home page listing devices and allowing for the addition or removal of a device, a notifications page detailing all recent alerts, and an account page where the user can see their information and log out. There is also a side menu containing buttons that link to our website, as well as an option to contact us through email. First time users will be greeted with a start-up page, allowing them to use Sign in with Google to log into the app. We chose this as almost all Android users will have a Google account and using it prevents us from needing to store passwords. All of these can be seen in our App UI detailed in the demo video.

The backend of the application is something that required a lot of thought and discussion, as well as decisions made on the physical hardware of the device. In the end we settled on that usage of a Particle Photon as the main computer due to its small size and free connection to a cloud service that can supply the app with API responses. Backend data will be stored locally on each device, and information that the app relies upon will be sent via the Particle cloud from the sensors on the device. This bypasses the need for a complex and price-inducing database without requiring the user to be on the same Wi-Fi as the mailbox in order to use it, solving many design problems in one.

3. Evaluation

In terms of physics, we have considered the feasibility of scissor lift and checked whether it worked effectively. We realised that although the scissor-like structure can simulate the lifting function to a certain extent, tension may be problematic. Therefore, even if only one pivot angle changes, the entire simulation will be affected. The force of the scissor fork will be uneven, the upper movable bearing platform and the lower base will be non-parallel, the operation of the lifting platform will be unstable, and the power system design and manufacturing costs will increase.

Figure 4. Original scissor lift

In order to implement 3D models in the future, we communicated and evaluated with hardware and mechanical experts. They pointed out that because there is no support mechanism under the scissor support platform, once a connection is broken, the platform will fall off immediately, which is prone to safety accidents. Moreover, the installation on site later is complicated and takes up a lot of floor space. We have considered these feedback and will use Motor lift instead of scissor lift to design the second sketch. The related accessories can also be obtained through 3D printing, so that the operation/simulation, movement, joints and control of the model provide effective support.

Figure 5. Motor lift

In terms of software, the initial software design included multiple login methods. After discussing with software engineers, we finally refined and improved our final model. (App UI Design at the end of page) Now it could display multiple users for a device and become more mature.

At this stage quantitative analysis is not informative however we have set out a range of tests and metrics that will be used, including confusion matrices for the future vision learning.

4. Budget

At present, we've not used any given budget. Due to the influence of pandemic, we've currently decided to carry out our project with a Webots simulation. However, we plan to use technician commissions during Phase 3 or Phase 4, if the simulation is completed with satisfaction and we have enough time.

However, in case of demonstrating the feasibility of the project, we've investigated the real cost for a physical prototype, elaborated as the breakdown table below. The major cost is spend on hardware building, since software development does not involve any purchase.

Items	♯	Cost(£)
Lift Motor	1	27.05
6mm+8mm Bright Steel Round Bar	1	15.00
MDF (per 8ft x 6ft x 12mm sheet)	1	11.00
12mm Thk T6 Aluminium Plate	1	10.00
3D printed material (5p per gram)	1	2.50
ON Semi PN2222ATA NPN Transistor	4	0.80
ON Semi 2N4403TA PNP Transistor	2	0.16
Nichicon 1F Electrolytic Capacitor	1	0.75
Vishay 50V 1A, Diode 1N4001-E3/54	4	0.80
Custom PCB	1	2.00
Steel Plates	6	45.00
UV Sterilizer LED	2	18.30
Door Spindle	1	8.40
Magnetic Lock	1	7.00
6mm Springs	4	12.00
Particle Photon	1	14.34
Total		175.10

The estimated cost maybe subject to change as project proceeds, we might find any parts maybe replaced or removed. The prices are acquired from the market. We have recorded the supplier of each item in meeting minutes for reference.

5. Video

Watch our Demo video here (SharePoint).

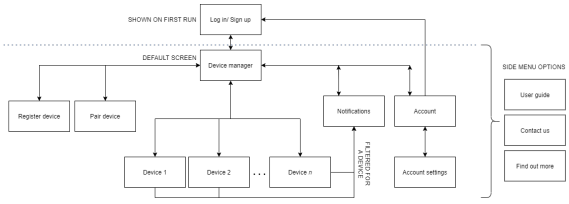

Figure 6. App Structure

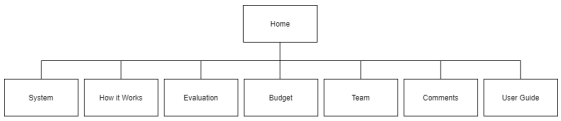

Figure 7. Web Structure

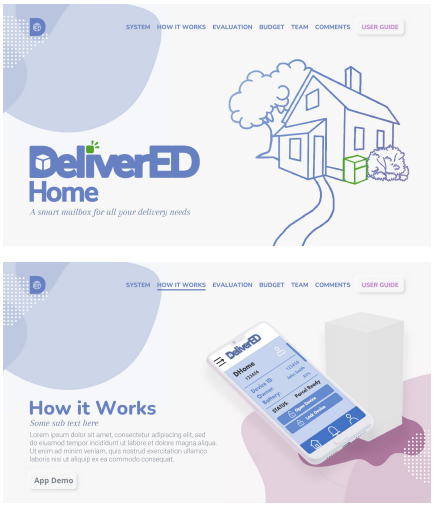

Figure 8. Web UI

Figure 9. App UI

References

[1] Neo Zhu. “DeliverED Questionnaire”. In: (2021). URL: https://shorturl.at/lHJP5.