Project 7/8: Integration beacons with Social-Buddy

General Information

Project Code:	**CMI-TI-23-TINPRJ0478**
Project Goal:	'Enrich the Buddy App with a Flic button a Tile tag'
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Document Version:	1

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1. Glossary

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Term	Definition
BLE	Bluetooth Low Energy. Operates like normal Bluetooth but with a different wavelength and uses less power.
Button	Flic button, a Bluetooth® button for Smart Home.
Buddy Bot application	The software that the elderly use to assist in their life. It has a Social Buddy avatar that can respond to the user's actions, using Face Recognition and Artificial Intelligent.
Cloud Firestore	A NoSQL document database service that can be used to easily store, sync, and query data for your mobile or web application.
Companion App	The software that the caregiver uses to assist in their job of taking care of the elderly. Made by the Social Buddy team.
Firebase	A cloud computing service and application development platform provided by Google.
GUI	A graphic user interface. It is something that allows users to interact with the underlying system without needing to know how it works.
(In)formal caregiver	People provide care for others who are in need. They are not professional healthcare workers, however, they are capable at their job. They can be unpaid (informal) or paid (formal) caregivers.
Social Buddy	Founded by Jack Jagt. They strive to develop a Buddy that can help seniors stay connected and give them the skills that they will need.
Tablet	A device that hosts the Buddy Bot application and serves as the beacon for the tag to calculate distance.
Tag	A Bluetooth® location tracking device, Tile Pro version. It is like an Apple Air Tag or Samsung Galaxy SmartTag.
Tile Pro	See "Tag".

2. Project's introduction and context

"The Social Buddy Foundation explores AI technology to improve self-reliance and prevent loneliness for elder and more frail members of society. Currently, many applications already exist to support older persons in their daily lives. However, interaction abilities are often limited due to poor voice feedback, or difficulties with touch sensitivity due to physical restrictions caused by aging." [1]– Social Buddy

Figure 1: Jack Jagt, the founder of Social-buddy.nl

There are currently many applications that are made to assist the caregiver in their jobs and the less fortunate in their lives. However, Jack Jagt finds the current selection doesn't do enough. He wants his application to be able to help the elderly to stay connected to the society. That is why he founded Social Buddy and hired many developers and designers to realize this project.

Aside from those volunteers, he is also interested in what could the students at Rotterdam University of Applied Sciences do. Jack, because of that, has allocated parts of this project as mini projects to the students at this university. For our mini project (as a part of the school's project 7/8), we were assigned to research and integrate a Flic button and a tag into the current system.

The system currently has 3 main parts: a Buddy app, a Buddy Bot app, and a database hosted on Firebase. The 2 hardware components must be linked to the Buddy Bot app on a tablet. The device is also used as a beacon for the tag the calculate the distance between those 2.

The idea behind this is to make the software more user-friendly for the elderly.

The button is used to notify the caretaker of when has the patient taken medicine. It can be where the drugs are at. When the medicine is taken, the elderly can just press the button to let the nurse know, instead of going to the tablet. The device may not be placed near the medication; therefore, it is for the elderly's benefit to use a button.

The tag is always by an elderly's side, may it be in pants or shirt pocket. It is used to locate the elderly to prevent them from wandering off without anyone knowing. The tag is connected to the tablet via Bluetooth® to calculate the distance. When the calculated space between the tag and the beacon becomes too big (approximately 100 meters), the caretaker will be notified to pay more attention to the elderly.

These 2 new functionalities will help the user's experience of the elderly and the caretaker become more streamlined.

3. Analysis

Some analyses before and during the project have been made. Every analysis is documented within the {./Documentation/Analysis/} directory. Within are the following analysis documents:

1. Stakeholders analysis
2. Risk analysis
3. Robustness analysis

3.1. Stakeholders analysis

The following are the main stakeholders for this project:

1. Social Buddy Project Team
2. Healthcare workers
3. Informal caregiver
4. Elderly/Senior

The Social Buddy team has a direct influence on this project and their headmaster is Jack Jagt. They are the ones who have worked on this project for years. They are also the ones who will be maintaining the code that they and we have written. Our group must work based on what they provide to us and consider their requests. This is also the only stakeholder that can regularly hold meetings with our group. We must be transparent about what we do and what we are struggling with.

The ones that are hard to keep in contact with are the healthcare workers, informal caregivers, and the elderly. These are the main users of this Social Buddy system.

Figure 2: An Informal caregiver with an elderly

Stakeholders 2 and 3 are the ones who will use the Companion app. They monitor the elderly's medicine intake and location for their safety. This project will provide them with a smoother experience with their work. They can give feedback about the system and their ease of use.

Currently, the fourth stakeholder, the elderly, must go to the tablet to confirm their medicine intake. This is not user-friendly, as most of the time, the medicine is not where the tablet is. As a consequence, they may forget to confirm it on the tablet. If this persists, the (in)formal caregiver may have wrong ideas about the senior's medicine intake, and this may cause serious problems. Our product must be easy for them to use, as they are often not tech-literate. They can give their feedback on the GUI, and the ease of use of the button and the tag.

These stakeholders are valuable to us. Not only they are who this app is designed for, but they are also the source of feedback which the developers can use to improve upon.

3.2. Risk analysis

The implementation of the button and the tag may impose risks on the intended users; thus those risks must be analyzed, and their solution and measure must be found. Some of them are essential for this project and will be thoroughly analyzed. Solutions and measures must be found and applied. On the other hand, some of them are either smaller risks that impose no real issues or they are

outside of this project's scope. These will still be analyzed as normal, although no practical solutions or measures will be applied to address this issue.

The following problems shall be addressed within this project, although everything is subject to change as the project progresses. Any changes will be mentioned under this list:

1. The user repetitively clicks the button.
2. Data of the button's response is not recorded correctly.
3. The button does something unsuspected.
4. Buddy bot doesn't respond accordingly to the user's actions.
5. Distance from the tag to the tablet is incorrectly calculated by more than 0.5 meters.
6. Distance is incorrectly recorded in the database (Firestore).
7. The connection between the tag and the tablet is unstable.
8. The connection between the button and the tablet is unstable.

Changes:

1. The problems 5, 6, and 7 are no longer needing addressed. This is a result of the research on RSSI distance determination with BLE. The RSSI value is not reliable enough to continue developing this feature. See Chapter 6.2 or the research report itself in {./Documentation/Research_reports/} directory.

3.3. Robustness analysis

Tag ↔ Buddy Bot

1. Tag cannot connect to the Buddy-Bot application
   - *When does it happen?*
     When the user tries to connect the tag to the Buddy-Bot application.
   - *Which measure did we take?*
     a connection to a tag is not needed for the app to function properly
   - *Did it help?*
     the tag functionality doesn't work but the app keeps running
2. The tag does not send accurate data to the Buddy-Bot application
   - *When does it happen?*
     When the tag sends the location data to the Buddy-Bot application
   - *Which measure did we take?*
     A precise measurement is not needed. We only need to determine if someone is outside or not
   - *Did it help?*
     No

Buddy Bot ↔ Firestore

1. The Buddy-Bot application does not connect to the database
   - *When does it happen?*
     When the Buddy-Bot tries to connect to the database
   - *Which measure did we take?*

when the buddy bot does not connect to the database the app tries to connect to it again

- *Did it help?*

yes

2.

Flic button ↔ Buddy Bot

1. The Flic button does not connect to the Buddy-Bot application
   - *When does it happen?*

     When the user attempts connect the Flic button to the Buddy-Bot application
   - *Which measure did we take?*

     we bult in a button so the user can try to connect to the flic button again
   - *Did it help?*

     yes
2.

Firestore

1. The database service is down
   - *When does it happen?*

     + When the server is down

     + When an intern messed up the database
2. - *Which measure did we take?*

   when the database is down the app doesn't go to the homepage
3. - *Did it help?*

   the user can't use the app until the server is back up again

4. Research

Everyone on the team must do at least 1 research and write a report about it. These researches have direct correlations with the project itself and they may help with the choices later down the line. The following subjects are researched. These researches can be found within the {./Documentation/Research_reports/} directory.

- Which BLE tag on the market is the most suitable for this project?
- How reliable is it to determine distance with a BLE tag using RSSI?
- What are the ethical implications of the usage of location trackers for patients who are at risk of wandering?
- What is the best state management solution to ensure the Bluetooth button works across the entire Social Buddy Bot app?

Each research will be briefly summarized here. These are from the “Conclusion” or “Result” chapter of their respective research.

a. Which BLE tag on the market is the most suitable for this project?

Among the available tracking devices, the Tile Pro tracker emerged as the best option due to its broad Android support, decent range, and practical battery life. Although it lacks some developer-friendly features, its compatibility and functionality make it a suitable choice for the Social Buddy application.

b. How reliable is it to determine distance with a BLE tag using RSSI?

The result from the experimentation is rather unfavorable for determining the distance between the tag and the Buddy Bot application hosting tablet. The calculated distance at low ranges is reasonably accurate. However, for the use case that the product owner wants (high range), the calculated distance values are rather too inaccurate.

It is also affected by the environment, which is hard to take account of. Each place that uses this system is different. Some places may have a lot of other signals that interfere with the BLE signal. Other places may have some objects that reflect this signal. These cause the signal not to follow a linear path, which decreases the accuracy of the distance determination.

It is advisable not to use a BLE tag to do distance determination. The technology is not yet efficient for such tasks. It is also not advisable to use closed-source tags for your system, as you may not be able to get your hands on the product's necessary information to develop. Then you have wasted your money on something that you cannot use.

c. What are the ethical implications of the usage of location trackers for patients who are at risk of wandering?

Location trackers have been shown to improve the quality of life for the pwd and their families. They provide an early warning for when the pwd is amiss and it allows their caretakers to retrieve them quickly before any accidents fatal or not occur.

When implementing such a system, compliance with the GDPR is of greatest importance. And the product owner must take the necessary steps to safeguard the privacy of their users.

Though the implementation of such a tracking system raises considerable and important ethical dilemmas and there is no clear-cut consensus on the appropriate usage of these trackers. Considerable care must be taken when suggesting the usage of location trackers. The project urges their product owner to consider the recommendations of (Landau et al., 2011) before the usage of these trackers. The recommendations that are made revolve around safeguarding both the pwd's autonomy, privacy and safety. Social buddy and the caretaker must at least have these procedures in place before considering the usage of trackers.

d. What is the best state management solution to ensure the Bluetooth button works across the entire Social Buddy Bot app?

Comparative Analysis

Solution	Performance	Usability
Provider	High	Easy
Bloc	High	Moderate
Redux	High	Moderate

All three state management solutions, Provider, Bloc, and Redux, demonstrate high performance levels, ensuring minimal impact on app responsiveness. However, Provider distinguishes itself in terms of usability due to its simplicity and intuitive design. Provider simplifies data allocation and disposal, reduces boilerplate code, and integrates seamlessly with Flutter's widget tree. This ease of use makes Provider the preferred choice for developers, especially those unfamiliar with complex state management patterns like streams in Bloc or the strict architecture of Redux. Therefore, Provider remains the most user-friendly option for integrating the Bluetooth button in the Social Buddy Bot app.

5. Product

During this project, 2 features were meant to be integrated:

- A Flic button to notify the caregiver when the user has taken medicine.
- A tag to notify the caregiver when the senior walks out of the user-specified range.

Here you can see how a process of 13 weeks has become. You may also have a better view of the end product after a demonstration video which is located in {./Media/Video/} directory.

a. The Navigation panel.

The navigation panel has 2 new buttons to navigate to the 2 new features that have been worked on. The new panel is to be seen in **Figure 3**.

Figure 3: The "new" navigation panel

b. The Flic integration

To use this feature, a Flic button must be paired to the device. From the navigation panel within the main GUI, press “Flic”. Then you will see a pairing UI pops up to let you connect to the button. (Figure 4)

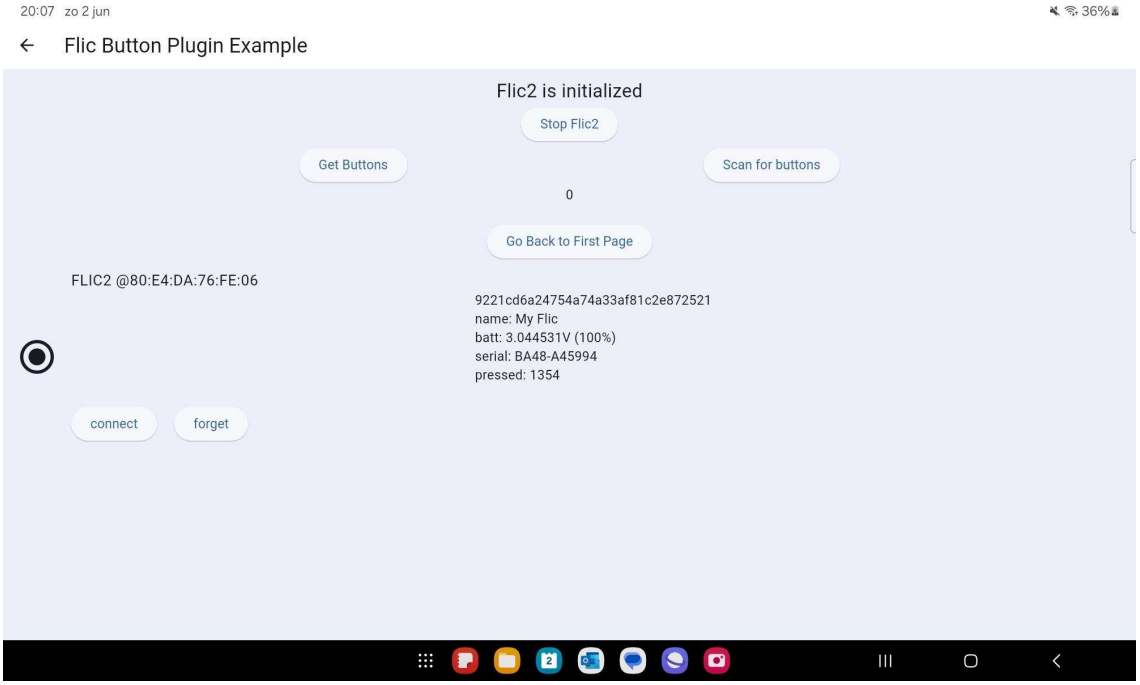


Figure 4: Flic button pairing interface

After successfully connecting to the button, you may go back to the main UI. When you press the button, the following UIs will show up in the Buddy Bot app (Figure 5) and the Companion app (Figure 6) respectively.

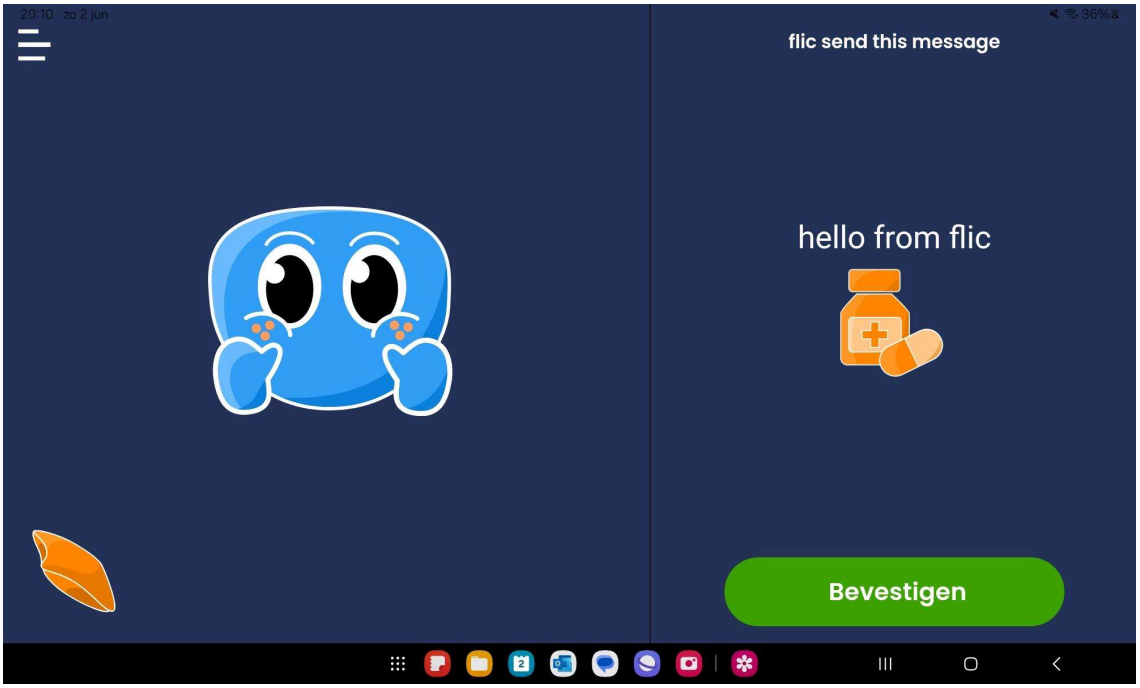
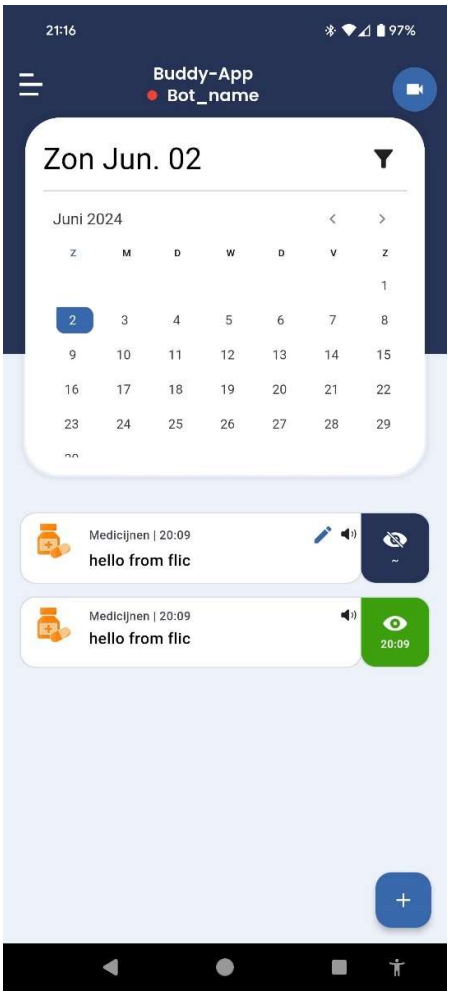


Figure 5: Buddy asking for you medicine intake



In **Figure 5**, the Event UI can be seen on the right side of the main UI. Normally it consists of a clock, but when an event comes, it will change to that event. At the time of the button press, a Buddy animation will be playedCurrently, the medicine intake event can be seen, and it needs confirmation.

In **Figure 6**, there are 2 notifications to be seen. The first one is the one that was just created after the press of the button and the second one was already created by an earlier button press.

This notification needs to be confirmed by the elderly to make the first one look like the second one. The senior can just go to the tablet and press “Confirm/Bevestigen” to confirm it. However, this defeats the entire purpose of integrating the Flic button into the app. The tablet is not where the medicines are. Besides, pressing a button on an app is still foreign to a lot of seniors. As such, the senior can also confirm the notification with the pose recognition feature that the Buddy Bot app already has.

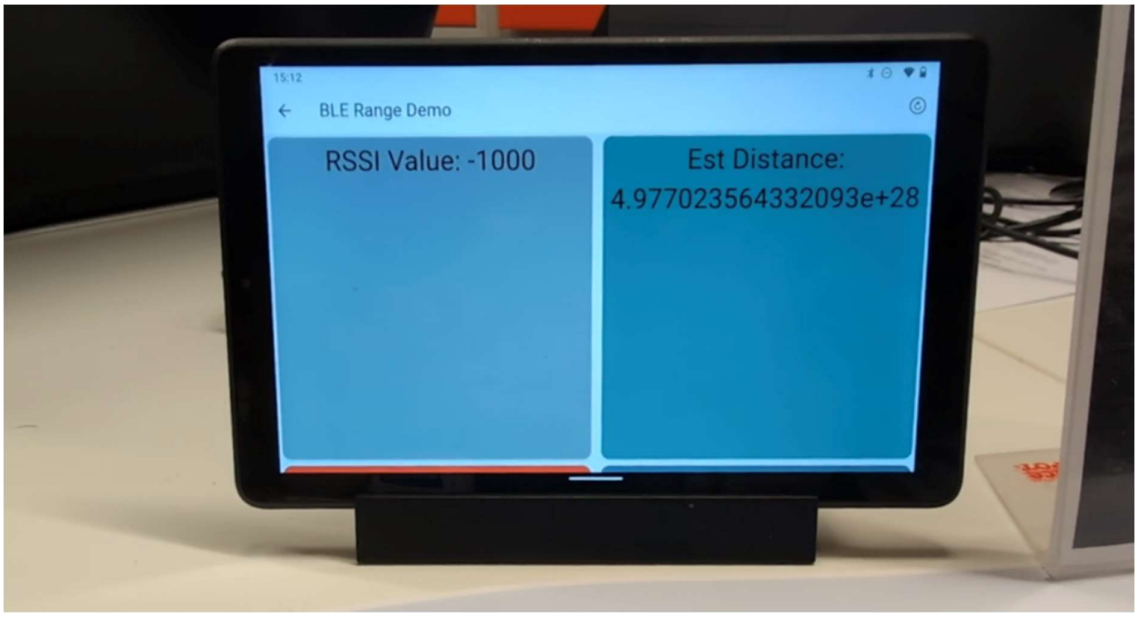
The elderly can stand in front of the tablet and raise one of his/her arms to confirm the notification without needing to go all the way to the tablet.

After either way of confirmation is done, the notification in the Companion app will look like the 2nd one in **Figure 6,** and a confirmation animation will briefly play in the Event UI of the Buddy Bot app and then turn back into a clock.

This feature could be improved. All transfer information will be in the {./Documentation/Transfer_documentation/} directory

Figure 6:Medicine notifications for medicine intake

c. The BLE integration



To navigate to the BLE page press on “distance BLE debug” from navigation panel within the main GUI. We couldn't find a way to find the tile tag automatically, so the app automatically only shows the values of the tile tag in our possession. The app shows the RSSI value of the tile tag and an estimated distance. The distance, however, is not calculated correctly.

6. Tests

Introduction

This document outlines the procedure for the user acceptance testing of the Social Buddy Bot. The aim of this test is to verify that the system meets the specifications and requirements of the end users, particularly the elderly and their caregivers.

Test Objectives

- Verify that the notification function via the Flic button works correctly.
- Confirm that caregivers receive notifications when the elderly person has taken their medication.
- Ensure that the system meets business requirements.
- Assess the usability of the system.

Test Environment

Hardware:

- Flic-button
- Tablet for the elderly
- Smartphone for caregivers

Software:

- Social Buddy Bot app for the elderly
- Caregiver Companion app

Netwerk:

- Wi-Fi/Bluetooth connection for the Flic button and apps

Testscenario's en -gevallen

Requirement	Expected result	Test result	comments
Pressing the Flic button to report medication intake	Social Buddy Bot receives notification and records medication intake	**Pass** / Fail	The patient found pressing the button not difficult
Notification received by caregiver via the app	Caregiver receives a notification that the elderly person has taken their medication	**Pass** / Fail	The caregiver immediately saw on her phone that the button had been clicked
Checking medication intake history in the Caregiver companion app	History displays correct user input information	**Pass** / Fail	The caregiver could easily find the history

Execution Date: 31/05/2024

Results:

Button usage was easy.

Notifications were clearly visible in the companion app.

Findings and Recommendations

Findings:

- The patient found the button easy to use.
- Caregiver was very satisfied with the notifications.

7. Conclusion

The Flic button has been completely integrated into the Buddy Bot app. The notifications are also correctly sent to the companion app. Since we didn't have access to the Tile Pro Tag SDK we couldn't completely implement the Tile functionality. In our opinion, the Tile tag was not the best option for detecting the distance between the tablet and the tag.

8. References

[1] "Over ons – BUDDY". https://social-buddy.nl/over-ons/

9. Image Sources

[Figure 01] https://social-buddy.nl/over-ons/

[Figure 02] https://www.istockphoto.com/nl/fotos/informal-carers

10. Change Log

Version	Date	Changes
0	12/02/2024	Document made, outlines only
1	13/04/2024	Added introduction and context
2	02/06/2024	Document updated