Smart Luggage

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Problem Statement

Frequent travellers may have to carry precious luggage over long distances. In many cases, the luggage of the client is hidden from sight. For example, when the client is travelling by train and has an upper berth, or when travelling by a bus with a separate cargo hold. In crowded areas, the luggage is susceptible to theft or improper handling. The device aims to protect the client from such issues. The objectives of the device are as follows:

1. Distance : The device must be able to provide accurate distance of luggage in real-time over small distances
2. Safe radius : The device must allow the user to set a safe radius for luggage, and notify the client if it is breached
3. Tampering : Device must notify the user of an attempt to force open the bag

Requirements

3.1 Functional Requirements

1. Authentication to allow device to recognise client
2. Estimate distance of device from client using Bluetooth signal strength
3. Set safe radius for luggage and lock/unlock luggage from client device
4. Maintain status of luggage flap using IR sensors to prevent tampering
5. Send notification to client device if safe radius is exceeded or in case tampering occurs

3.2 Non-Functional Requirements

1. Robustness of device to allow portability
2. Low Power consumption to allow device to last journey
3. Compact size so that device can fit in luggage

Requirements(Contd)

3.3 Harwdare Requirements

1. Bluetooth module
2. IR/Proximity sensors
3. TIVA C Series board
4. Potable power source (eg. Power Bank)
5. Android device with Bluetooth functionality

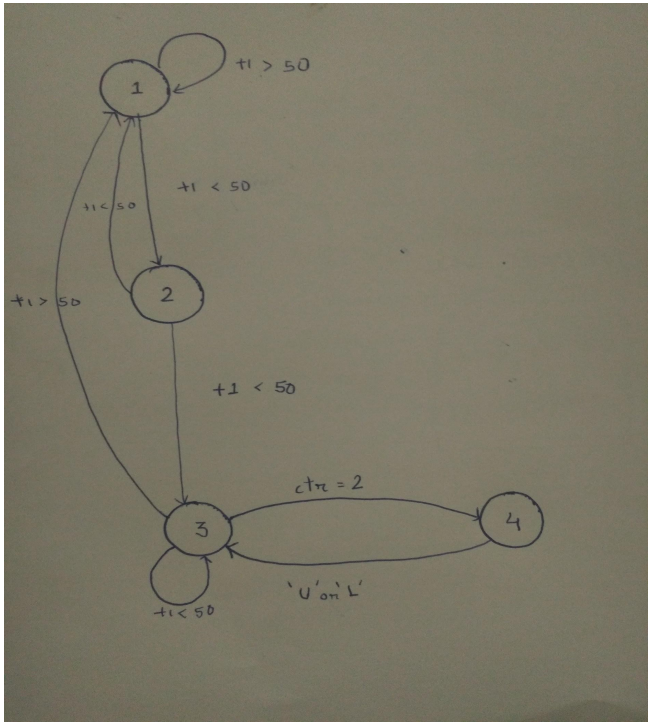
3.4 Software Requirements

1. Android system to support the Smart Luggage Application

Plan

- State machine for implementing logic for IR sensors : 10 Mar (Aakash, Depen)
- Sending/Receiving messages through bluetooth module : 21 Mar (Royal, Depen)
- Developing bluetooth protocol for communicating with TIVA board : 28 Feb(Aakash, Paramdeep)
- Creating UI for mobile app : 27 Mar (Royal, Paramdeep)
- Testing and calibrating the device : 5 Apr (Aakash, Royal)
- Adding background notifications and alarm : 2 Apr (Depen, Paramdeep)

FSM



Innovation and challenges

- Protocol between device and bluetooth for efficiency
- Bluetooth pairing and signal strength monitoring concurrently
- Authenticating device
- Bluetooth strength to distance conversion
- Handling bluetooth strength fluctuation
- Effective notification mechanism

Task Completed

1. Authentication to allow device to recognise client: The bluetooth module was secured with a pin code, which needs to be entered when connecting to it. This is known only to the user of the device(if he properly secures it)

2. Estimate distance of device from client using Bluetooth signal strength: We collected multiple readings of distance vs strength. Also, as the strength fluctuates a lot, we implemented averaging to get the correct distance.

3. Set safe radius for luggage and lock/unlock luggage from client device: As different persons have different requirements, they are provided with different options for setting the safe distance. Also, communication protocol between application and device was implemented for locking/unlocking luggage from client application.

Task Completed(Contd)

4. Maintain status of luggage flap using IR sensors to prevent tampering: IR sensors were continuously monitoring the distance of flap and this signal was continuously being sent to the TIVA Board

5. Send notification to client device if safe radius is exceeded or in case tampering occur: Using the communication protocol between application and device, a signal was sent to the application if device went out of range or tampering occurred and an alarm went off in client's phone

Test Cases

Bag opening :- We have to detect if there is any tampering with the device. Thus, to prevent it, we check if the bag is opened. The test was performed by placing a device inside a bag with the flap and when the flap was opened, alarm went off on client's phone.

Device out of range :- If device is out of the safe distance, an alarm should be sent to the user. This was checked with different safe distances - 3 meters, 5 meters and it worked fine, although there was a bit delay in the alarm.

Device not detected :- If device dysfunctions somehow, then the client should know about it. This was ensured by turning off the device and alarm went off on client side.

Test Cases (Contd)

Performance :- All the communication between device and mobile takes a delay of about 2 seconds.

Re-usability features

The communication part of our mobile app is independent of the device, so we can replace it with any other communication protocol like X-bee, GPRS.

Our module is independent of the following:

1. Android version
2. Mobile specifications (including mobile bluetooth)

The Smart Luggage application works as a standalone product in the sense that it can be used to bind any Bluetooth device to itself. Features such as real-time display of approximate distance are not limited to the embedded system designed for Smart Luggage.

Future Enhancements

Some of the possible extensions to the project are as follows :

1. Extend the application to monitor multiple devices at the same time, and allow the client to lock/unlock each one independently
2. Extend the embedded system to force an alert message to any nearby devices with the Smart Luggage application in case of an alarm raised. Thus if the bag is dragged out of the safe radius, people near it would be in a position to spot it
3. Attach a GPS/GPRS module to log the time and location in case of any alarm raised. It will also help to track the luggage over long distances
4. Data gathered about time and location thefts as discussed above, can be used to make customers vigilant when they enter a suspicious area