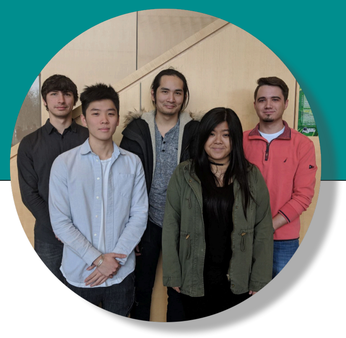

FREIGHT SHIPMENT MONITORING DEVICE

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ABSTRACT

Customer Development of this device was carried out by FSMD2 for the ACME Corporation.

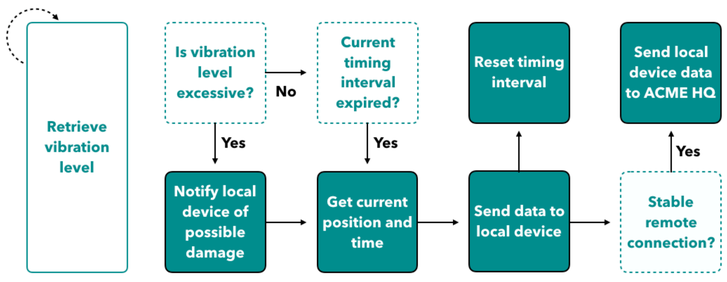
Background In the United States, 79% of people utilize some form of online shopping. Approximately one in ten packages is damaged during the shipping process, depending on the carrier used. Additionally, damaged packages account for 43% of negative customer satisfaction reviews regarding online shopping.

Problem & Purpose Poor handling is often the cause of damaged parcels. To combat this issue, a microcontroller-based freight shipment monitoring device (FSMD) was developed for systematic damage detection. The device is required to monitor geolocation, time, and vibration profiles of an individual parcel in transit. The status of each FSMD is then monitored by shipment personnel via an Android device.

METHODOLOGY

Data acquisition & Operation An accelerometer measures the average acceleration over 30 minute intervals. Additionally, shocks above a configurable threshold are reported. At the end of the interval, the current time as well as location are determined using a GPS component. A WiFi module is then used to transmit the acquired data to the Android device. These three data points detail possible damage in addition to when and where the possible damage occurred.

Android development Using Java and XML in Android Studio, as well as several Android development libraries, a user-friendly application was written to provide shipment personnel with the means of easily monitoring each FSMD whilst in transit. An application-layer protocol was designed to retrieve data from the FSMD. Received data is then stored into a SQLite database to facilitate easy export of information.



Functional Flow Diagram

RESULTS

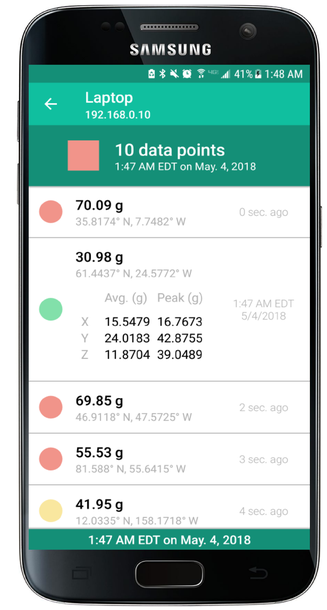
Implemented features The following requirements were fulfilled and implemented in the FSMD:

- Vibration profiles, time, geolocation data points are acquired and stored.
- Excessive shocks are successfully detected.
- The FSMD transmits acquired data to an Android device at the end of a configurable interval.
- All events are captured and stored properly by the developed Android application.
- The Android application presents data in an intuitive manner for the user.
- The dataset can be easily exported through the user interface of the application.

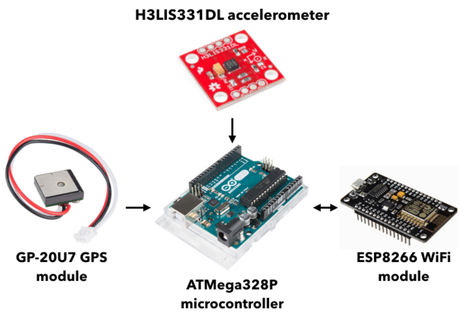
Technology Used

Component	Details	Current	Price
H3LIS331DL	± 100 gs of acceleration	300 µA	$10
GP-20U7	2.5m accuracy	40 mA	$16
ESP8266	802.11 b/g/n support	135 mA,10 µA*	$7
ATMega328P	Programmed with Arduino	6.48 mA, 4.3 µA*	$22
Adafruit 328 LiPo	2500 mAh rated at 3.7 V	–	$16

*Low-power mode



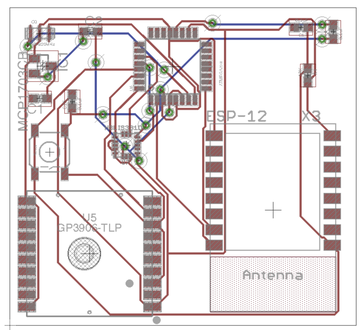
Android Application
Item Details View



Hardware Components

Physical specifications Through automated design tools, a mockup Printed Circuit Board (PCB) design was drafted using the required components and measured to be 4.5 cm x 4 cm.

Power consumption In a mobile system designed for lengthy use cases, power consumption is critical. The total average current for these components was approximated to 1.42 mA over a 30 minute period. And with 1.42 mA per 30 minute period, a 3.7 V 2500 mAh battery should yield 5.3 mW for around 70 days of battery life.



Printed Circuit Board Design

CONCLUSION

Summary The FSMD was developed for systematic package damage identification utilizing a microcontroller and the instruments aforementioned. Both precise geolocation and relative acceleration measurements were reached and data is successfully able to be transmitted to an Android device, demonstrating proof of concept for the module. Though not implemented, a printed circuit board (PCB) layout was designed and a mock physical model was 3D printed for visualization.

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