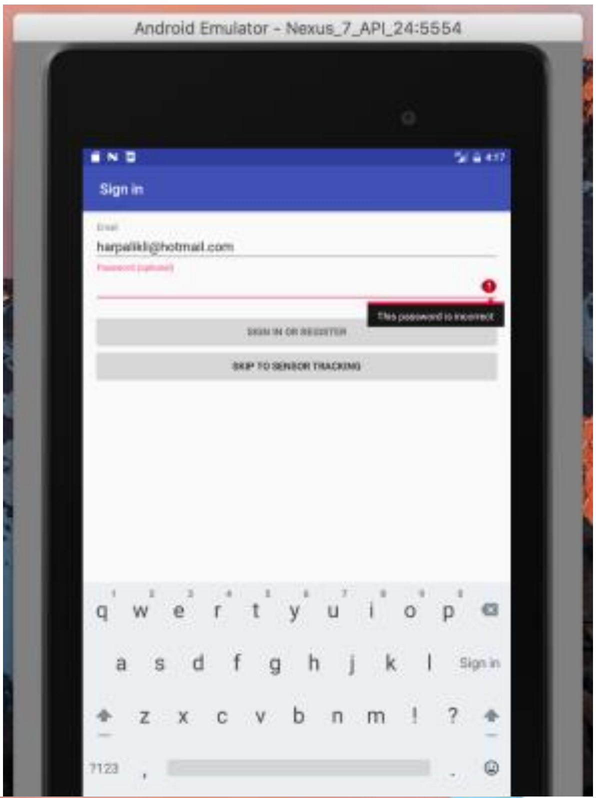
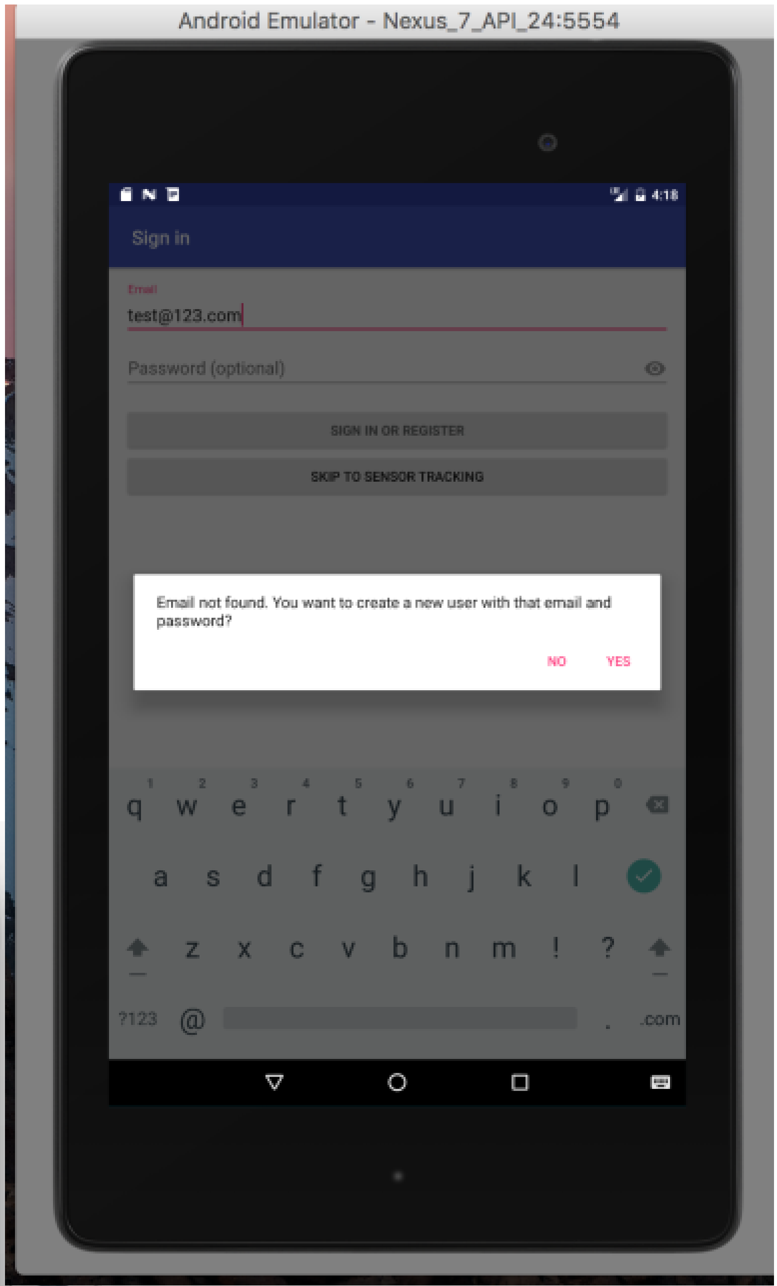
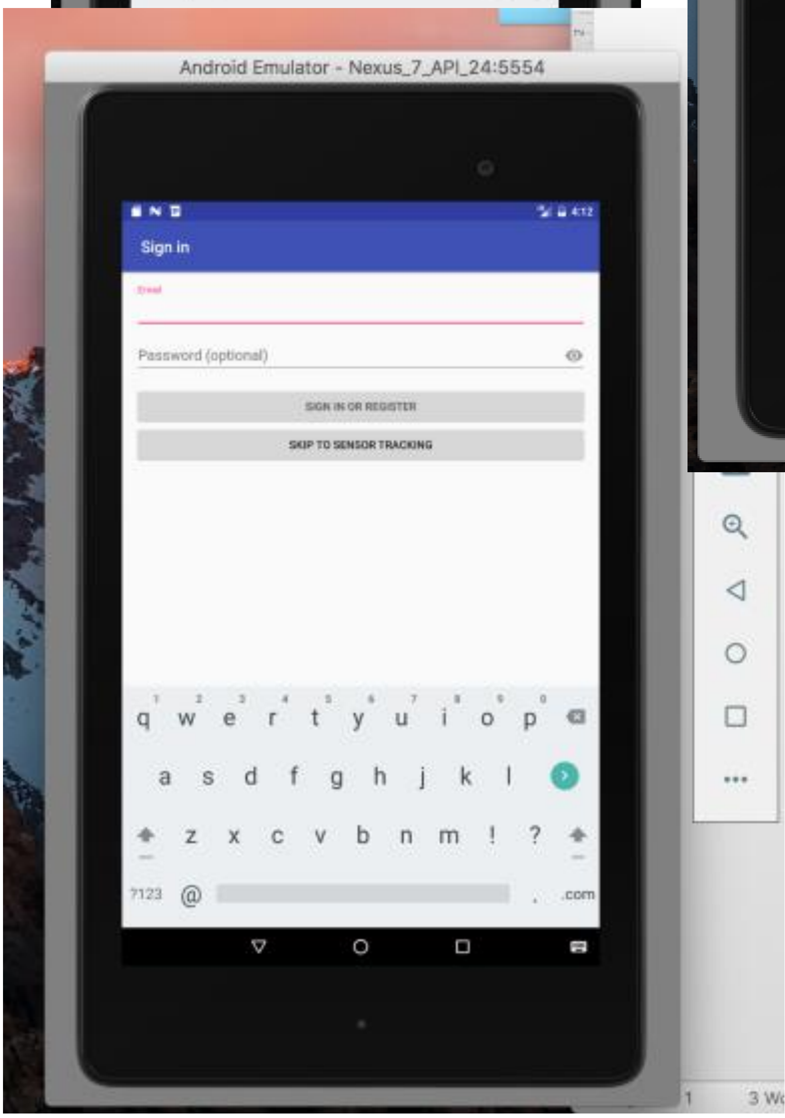
Huseyin Arpalikli - 13153439

Report and Results







From this initial login screen on the app, users can either log in using saved login details or register if the app SQLLite database doesn't recognise the login details entered. If email is not found a dialogue appears asking a user to register, if they decide not to register then the user cannot continue to location tracking. If a user clicks 'YES' on the dialogue, the system will take them to the next activity, which is location tracking.

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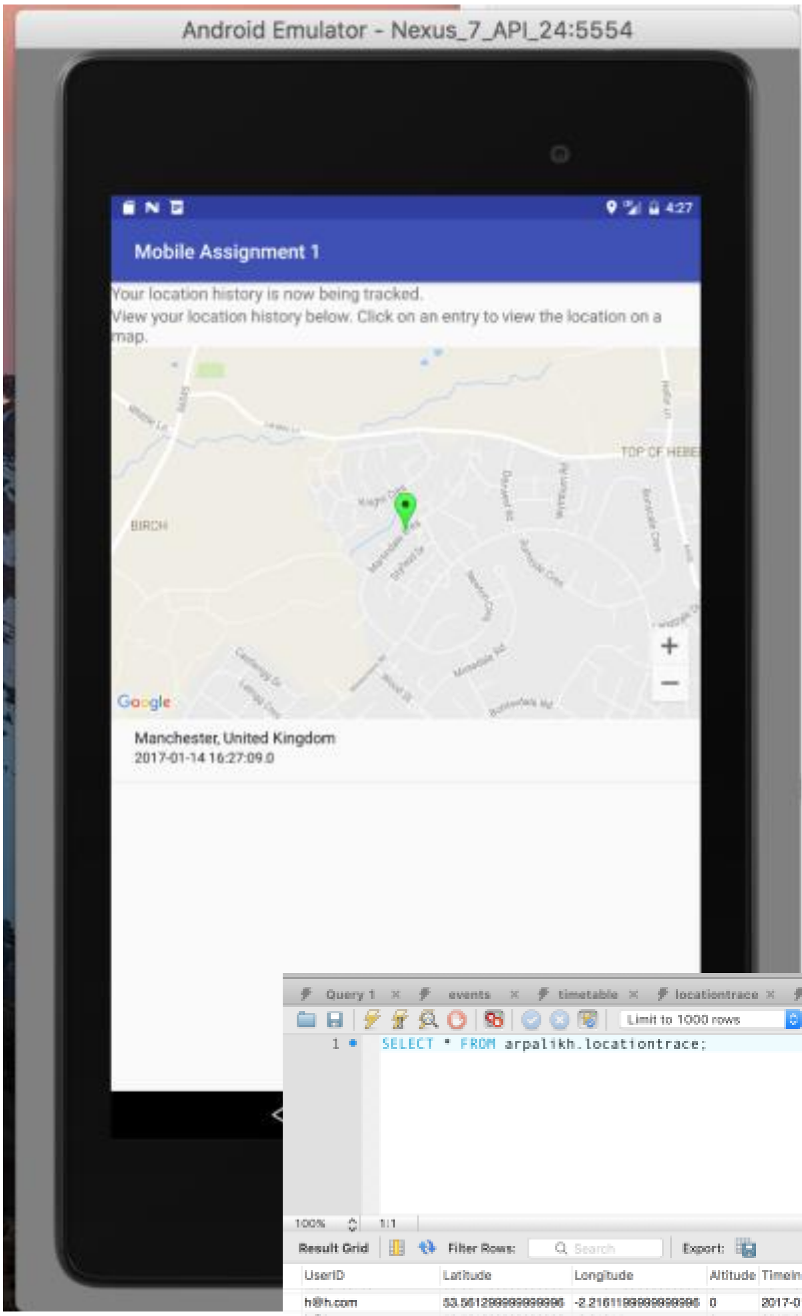
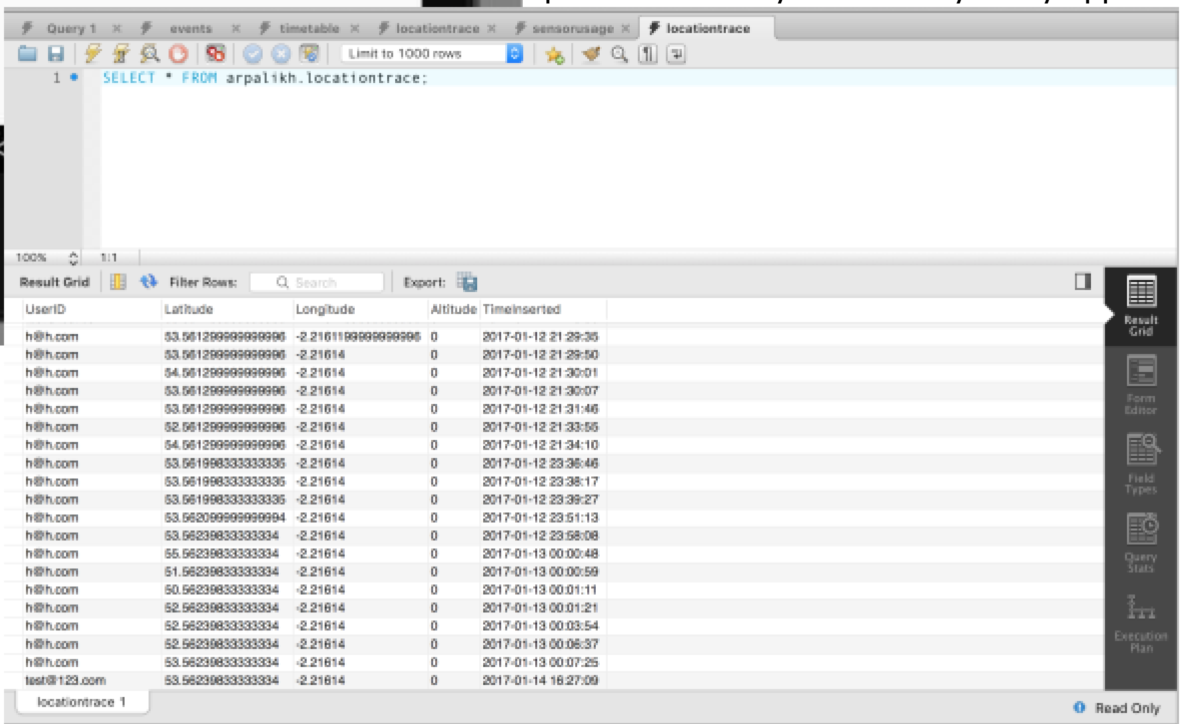
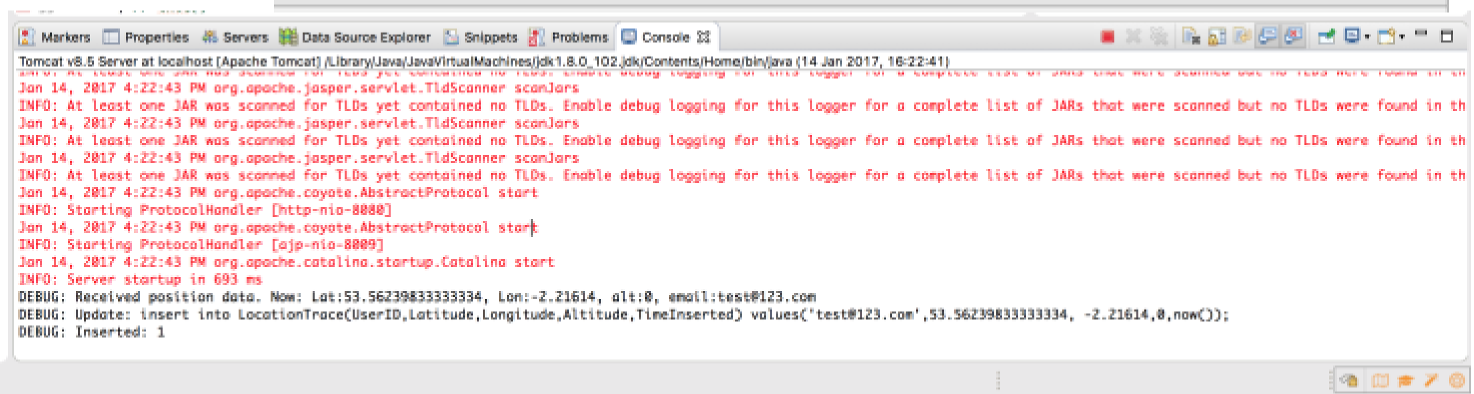


After login, users will see the following screen. The map will display the user's current location when the app is opened. At the same time, the current location latitude and longitude are sent to the servlet. The servlet then sends this data to the database. Whenever the location has updated the data sent to the database is simultaneously retrieved back from the servlet that uses objects and DAO's to retrieve all location history for that particular user.

In the example to the left, Manchester is the only location on the list. This is because the new user 'test@123.com' with no password, has only had the current location stored. When this location changes, the new location would be added to the list. To make the app for user-friendly, I have used the Geocoder class in the Google API which takes the latitude and longitude and returns the location in various formats such as address line, locality, city, country, etc. I picked to use city and country in my app as it seemed the best option to avoid issues with locations of roads and in small villages not being found by Google Maps.





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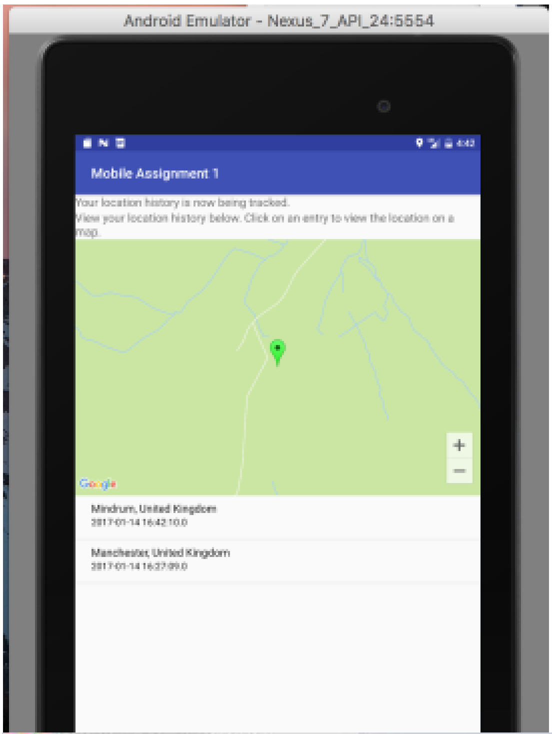
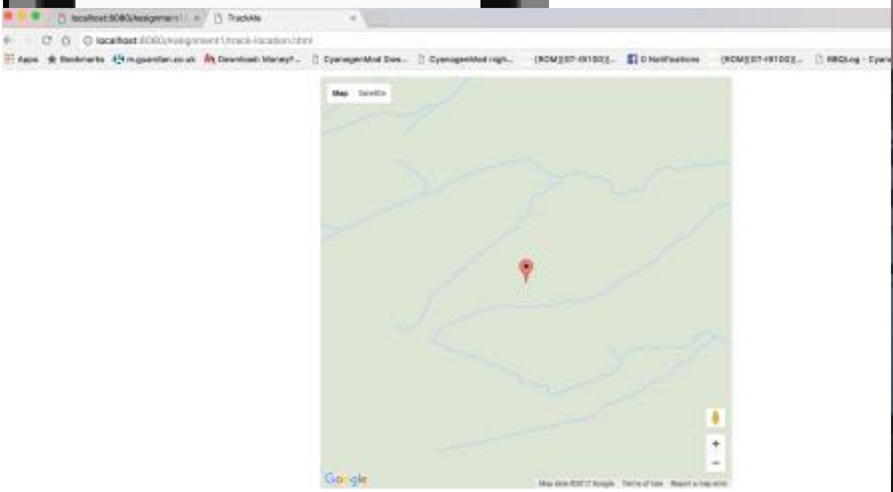
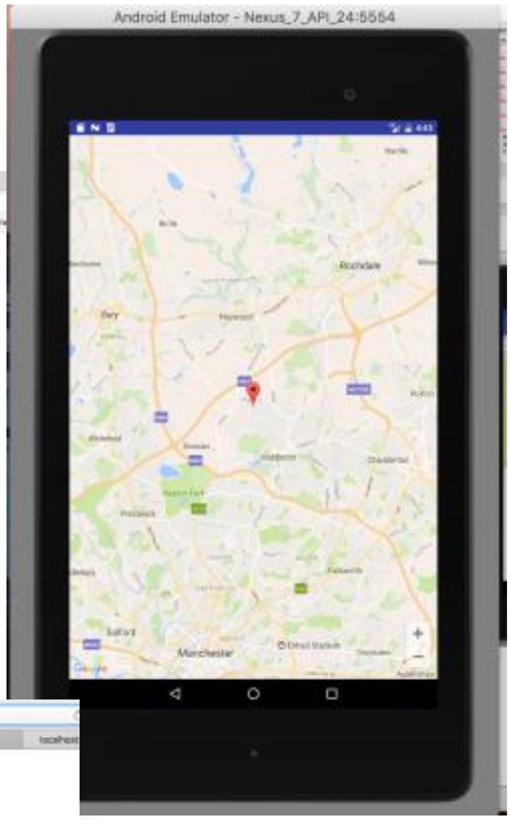
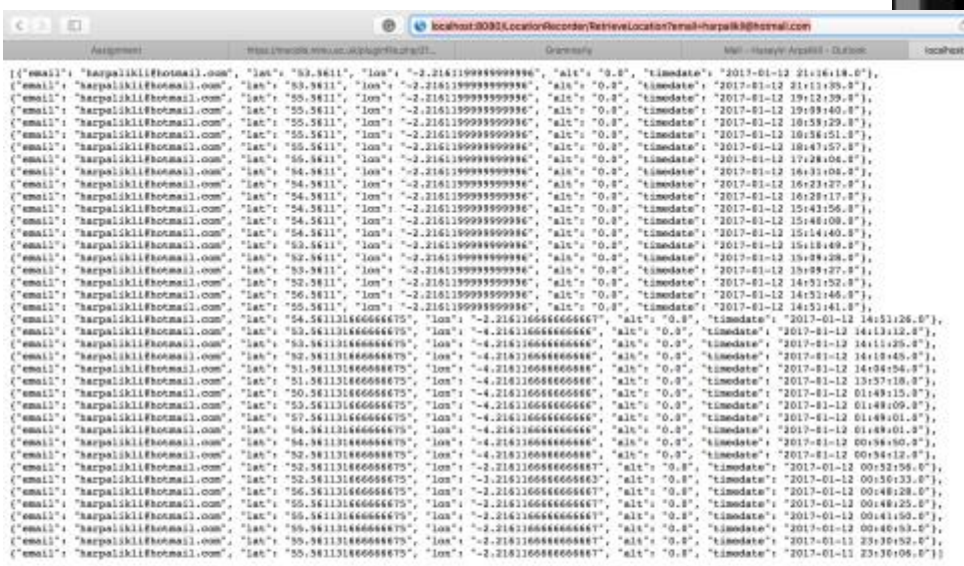


When the user clicks on a list item of their history, they will be able to see the exact location recorded on a map in a new activity. From here they can use the back button to return to the main location tracking screen.
The example on the left shows the location changed and the latest location history added to the database via the server as well as it being retrieved and returned to the ListView widget. The example below shows the location of a location item in the list. If the current location is in an unknown city, then the list will display 'Unknown City' to notify the user that the system could not find the city of the specific latitude and longitude values.

The system I have created can return location tracking values for a user in JSON as well as use this values to track the last location in a

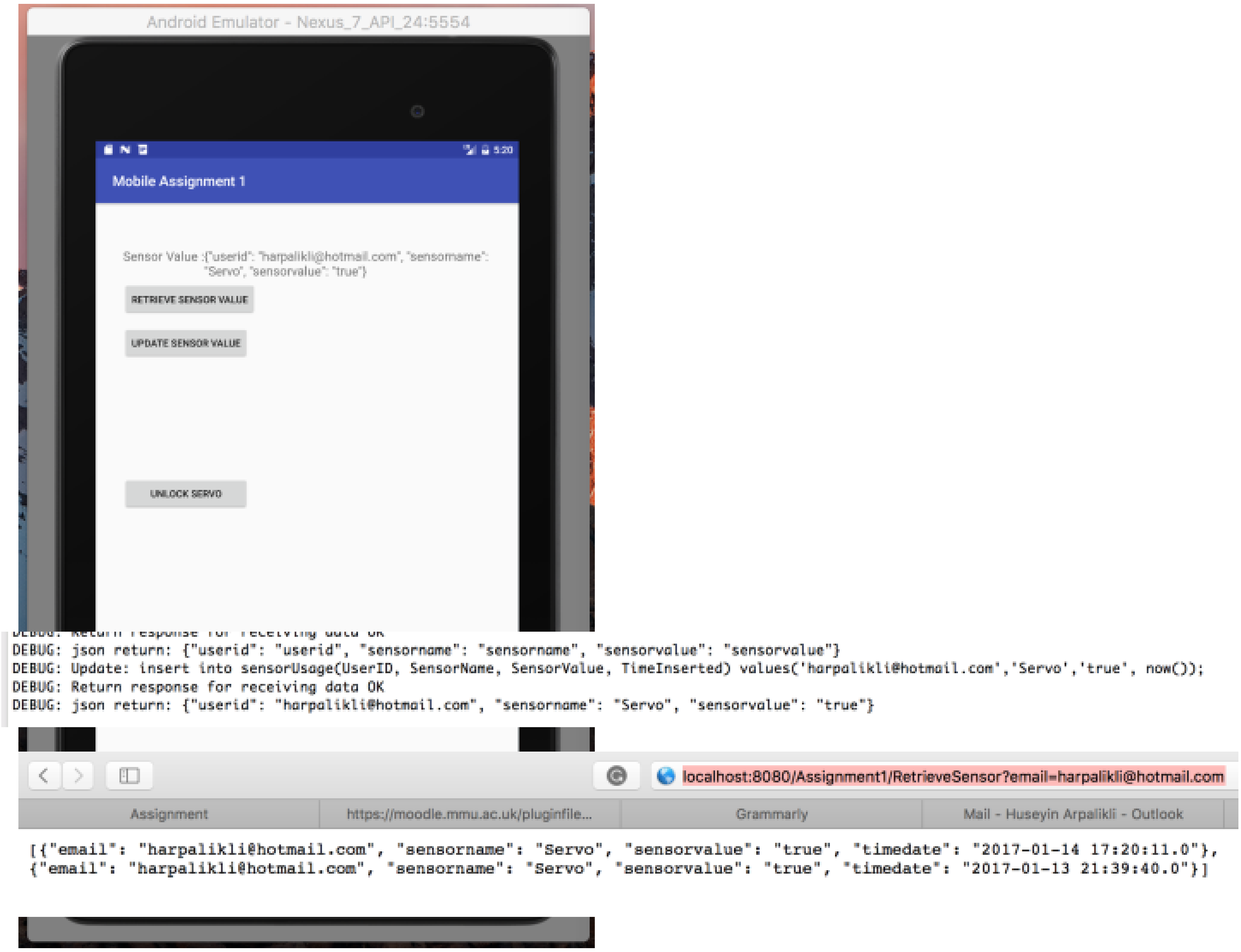






JavaScript, HTML map (track-location.html). See the JSON location data returned below for user 'harpalikli@hotmail.com' with password 'huseyin'. Task 1 conforms to the requirements for the mark scheme as the program sends values to the server, all required values are stored in a MySQL database; the values are then retrieved and returned to the app from the server. Location data is returned in a structured format, JSON data is returned, maps are available on request, and there is further development of functionality (the login system and Geocoder use).
Unfortunately, I did not complete Task 2. However, I did start it and carried out some implementation. I was able to carry out the creation of DAO's and Java objects to retrieve sensor

data from the database which was able to be sent and received from the android app. The server could make and receive requests for sensor data in JSON, and I made a start in attempting to trigger sensors from the app. The 'Unlock Servo' button sends a request to the server, which in turn sends a request to the database. This is then meant to be retrieved in the client class 'RFIDtoServo', which would listen for the last database sensor value to be true and when this occurs the client application 'RFIDtoServo' would trigger the servo motor. In the app example below the 'Unlock Servo', then 'Retrieve Sensor Value' buttons have been pressed, and the data shows the returned JSON values for the last server request for a particular user. See the logs below that show the returned message when the request is sent to the server. The below browser example shows the returned JSON array data showing the sensor details retrieved from the database using the 'email' parameter to show data for a particular user. In the example the email used is 'harpalikli@hotmail.com'.



Although my task 2 and 3 work are incomplete I have made an attempt at implementing the server and app communication part of the tasks where I have been able to send and receive data between the two and my task 3 is partially done; where I have used widgets and effective GUI to use the built-in GPS sensors as well as successfully connecting to the server to send and receive actuator data, even though the physical sensors didn't work. The main issue I had with the implementation for getting the actuator to be triggered; was because I was unsure where to put my 'userTrigger' method in the RFIDtoServo class to listen for a request from the app to the server. The way I had partially implemented this trigger method was to check for a 'userID' in the database when the sensor name and sensor value was set to 'servo' and 'true', respectively. The 'userID' is then sent to the method that checks that the user has been authenticated as an 'allowed' user and if so the openDoor method would trigger the servo motor to open for 5 seconds then close again.

The method above was able to retrieve the triggering value sent by the app to the server using the function ‘getLastTriggeredVal’, which then used a HTTP request to the server and GSON to retrieve the values to store in Java variables. See the implementation for these discussed methods below.

```
public static ArrayList<String> getLastTriggeredVal() throws IOException {
    String sURL = "http://localhost:8080/Assignment1/TriggerSensor?triggerservo=true"; //just a string

    // Connect to the URL using java's native library
    URL url = new URL(sURL);
    HttpURLConnection request = (HttpURLConnection) url.openConnection();
    request.connect();

    // Convert to a JSON object to print data
    JsonParser jp = new JsonParser(); //from gson
    JsonElement root = jp.parse(new InputStreamReader((InputStream) request.getContent())); //Convert t
    JsonObject rootobj = root.getAsJsonObject(); //May be an array, may be an object.
    ArrayList<String> data = new ArrayList<String>();
    data.add(rootobj.get("userid").getAsString());
    data.add(rootobj.get("sensorname").getAsString());
    data.add(rootobj.get("sensorvalue").getAsString());
    return data;
}
```

```
private boolean validUser(String searchUser) {

     boolean userAuthenticated = validUsers.contains(searchUser);
     System.out.println("User checked as valid - " + userAuthenticated);
     return userAuthenticated;
}
public void userTrigger(String userID) throws IOException  {
     // Check tag value and move if necessary
     String userIDFound = userID;

     System.out.println("User triggered - " + userIDFound);
     if (getLastTriggeredVal().get(2)=="true"){
         if (validUser(userIDFound))  {
             // open door lock
             openDoorLock(servoNumber);
         }
         else {
             System.out.println("Non-recognised user for lock - "+userIDFound);
         }
         String validUser = String.valueOf(validTag(userIDFound));
     }
     //String sendResult = sendToServer(userIDFound, "Servo", validUser );
}
```

SENSORS IN HEAT: URBAN SENSING IN AN INTEGRATED STREETLIGHT PLATFORM

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Urban Sensing in Streetlight Platforms

1. Introduction

The Internet of Things (IoT) is a broad concept of an infrastructure which includes multiple devices that are interconnected and have the capability to communicate with each other. These devices can be many different things, and among other notable devices, sensors are one of the most dominant devices in the Internet of Things concept. Sensors are devices that can send and receive data based on various attributes in the environment. Sensors are used for reasons such as detecting movement, temperature, the location of a device, weather along with many other purposes. With the opportunity of some many possibilities, sensors can be used to encourage sustainability. The idea of improving the urban environment and being eco-friendly is called urban planning. According to Mohring, K et al. (2015), carrying out urban planning requires a large scale of work, where large collections of data surrounding the environment. Achieving this can be completed via an approach known as urban sensing. Urban sensing is where sensors collect data about the urban environment. These sensors can provide data about power consumption, temperature or humidity over a period.

This report will be covering urban sensing through the use of integrated streetlight platforms, and it will provide a background study, advantages, disadvantages, solutions to problems and a conclusion in sections '2' till '6', respectively.

2. Background

Urban sensing is a technique that investigates the use of digital environmental sensors in urban environments to promote sustainability. Citizen Sense (2016). Significant amounts of data containing the results of the urban environment sensors are collected. Sensors are capable of collecting data about humidity, temperature and data on traffic that can be collect through the use of movement sensors. The data collected would then be analysed to find ways to improve urban environment by trying to increase sustainability based on data gathered. For the data collection to be effective, the sensors in the urban environment are placed in a wide radius. Commonly, sensors were installed in private properties and the areas surrounding this to collect data. This meant that installing sensors in the urban environment could be a struggle depending on where sensors are placed. When sensors were installed on private land, permission from owners was required along with the need for access when maintenance on the sensors would be necessary. As a method to overcome this issue, the idea of installing sensors on streetlight platforms had come to light. Mohring, K, et al. (2015).

During the conference, Mohring, K, et al. (2015, said that sensors combined with the already available, streetlight platforms are a boost from the use of satellite imagery and sensor stations that were previously used to collect data about urban growth. The reason for this was because this imagery could only gather data about hotspots and growth. Another problem with satellites is that they can't give as much data as sensors. Sensors can quickly identify temperature and humidity of the air, as well as the traffic information around urban environments. As well as this, data collected using sensors would provide much use in other research, for example, conservation studies.

3. Advantages

There are many benefits of integrating streetlights with urban sensors as opposed to sensor stations within private land. One advantage of using urban sensors combined with streetlights is the fact that the sensors would be protected from damage because of their placement above lights. Sensor equipment would last longer and reduce the cost of urban planning as it would be difficult for the sensors to be vandalised, therefore avoiding the cost of unnecessary costs for repair, administration and replacement. Mohring, K, et al. (2015). Urban sensing on streetlights rely on various nodes (or in simple terms, 'devices') being able to communicate with each other and as streetlights are usually in the line of sight of each other and streetlights are often placed at equal distance from each other. These benefits mean that communication between sensor nodes placed on streetlights is ideal to avoid unnecessary interference and that the data collected will prove to be more reliable and consistent compared to the sensors on private properties. Mohring, K, et al. (2015).

Per Mohring, K, et al. (2015), streetlights being positioned around houses and roads means that data collected from the sensors on them would provide high interest for urban planning as these areas would be key targets for the purpose of using the sensors to help in producing a sustainable environment.

Another advantage of urban sensors on streetlights is that all the street lighting is publicly owned and this would mean that there wouldn't be a need to obtain permission from any private owners and risk rejection.

Sensors on streetlights would require electricity to operate, and where sensors proved an issue when installing sensor stations in private properties as the portable power that would run out, streetlight integrated sensors would be able to be directly powered by the power supply in the streetlights. Using the power from streetlights would mean that less maintenance would be required on streetlight sensors compared to private property sensor stations, as they would require frequent replacement of the power source as well as the problem of having to obtain owner's permission to maintain the sensors. Mohring, K, et al. (2015).

4. Disadvantages

One notable disadvantage of using urban sensing on streetlights is the issue of heat. Heat is formed by the streetlight as well as the lighting control equipment. The developed heat would remain trapped inside the housing of the lamp, and this could result in the sensor recording incorrect and unreliable data. This is due to the readings of the heat in the air being merged with the readings for the heat from the light. Mohring, K, et al. (2015).

As well as this, there would potentially be an issue with high levels of heat and humidity within a tropical environment, which as well as proving unsafe due to exceeded safety margins of the sensors, would also cause corrosion and reduced longevity of components. This would mean that the cost of maintenance would be higher because of the need for more frequent repairs and replacement because of sensor damage. To prevent corrosion, the sensors would need to be protected in an enclosure. This enclosure could interfere with the data of the air temperature as contact with the open air would be needed to provide reliable results. Mohring, K, et al. (2015).

5. Possible Solutions

One solution to the issue with enclosures can be solved using an insulation technique that has been studied. This insulation method involves surrounding the sensor casing with a reflective foil. Mohring, K, et al. (2015). The foil would then insulate the sensors and absorb heat from the streetlight sensors. This would resolve the problem of extreme heat damaging the sensors (see section 4). A disadvantage of this solution is that it would not be as useful in non-tropical environments. The use of an insulating foil could also cause further incorrect readings as the foil would introduce another layer that would affect air contact with the sensor.

There are other potential methods of collecting data for urban planning. One possible solution to urban development planning is the use of satellite imaging to find the urban areas and to identify growth. Satellite imaging can be used to produce land-maps outlining the current status of the urban environment. This can then be used for geographic information systems and can provide updates to topographical maps that can be utilised for tourist maps and maps for different themes. Sunar Erbek, F. et al. (2005)

6. Conclusion

In conclusion, urban sensing via streetlight sensors could potentially be an ideal method for urban planning. However, further research and study would be required to make improvements. One improvement needed is the use protective casing for the streetlight sensors to prevent damage from environmental factors; the protective housing would need to solve the issue of direct air-to-sensor contact to avoid inaccurate readings. As well as this, improvements in the placement of sensors will be required. The current positioning of sensors could mean that data could be inaccurate due to the heat produced by streetlights.

As explained by Mohring, K, et al. (2015), sensors would be housed inside 'luminaire housing' which would mean that sensors wouldn't be exposed to the same amount of direct sunlight, but the use of housing would still mean that the sunlight would in turn trap heat inside the housing. A mentioned solution to this in the pilot was to paint the tops of the housing white to reduce heat absorbed, but there would still be an issue with heat being absorbed in the housing which would cause inaccurate readings. To solve this problem, further study into effective insulation methods would need to be carried out to ensure results are as accurate as possible.

Lastly, the study on alternative methods of urban development planning will need to take place. This is so that all factors can be compared and considered. The cost efficiency of the streetlight sensing method would need to be compared with other methods so that an appropriate solution providing the most accurate results under a fixed budget is selected

7. References

Citizen Sense. and Gabrys, J. (2016) *Urban sensing*. 10th November. [Online] [Accessed on 14th January 2017] http://citizensense.net/projects/urban-sensing/

Mohring, K., Myers, T., Atkinson, I., VanDerWal, J. and Van der Valk, S. (2015) 'Sensors in heat: A pilot study for high resolution urban sensing in an integrated streetlight platform - IEEE Xplore document.' *2015 IEEE Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP)*, pp. 1–6.

Sunar Erbek, F., Ulubay, A., Maktav, D. and Yağiz, E. (2005) 'The use of satellite image maps for urban planning in Turkey.' *International Journal of Remote Sensing*, 26(4) pp. 775–784.