Relative localisation between vehicles for vehicle to vehicle communication for safety applications

Can we make cars that cannot crash?

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Introduction

With 1.24 million road fatalities in the world and a constant increase in the number of vehicles, there is an immerse need for increasing car safety. Our project works towards creating electronic systems to be incorporated in vehicles to automatically stop vehicles when an accident is about to occur.

The cost of such a system is very important for the systems to be widely employed. We are therefore using a cheap software defined GPS receiver connected to a car. Previous research [1] shows that in theory this device should be able to provide precise enough GPS data for calculation of the distance between vehicles, which is the main requirement for such systems.

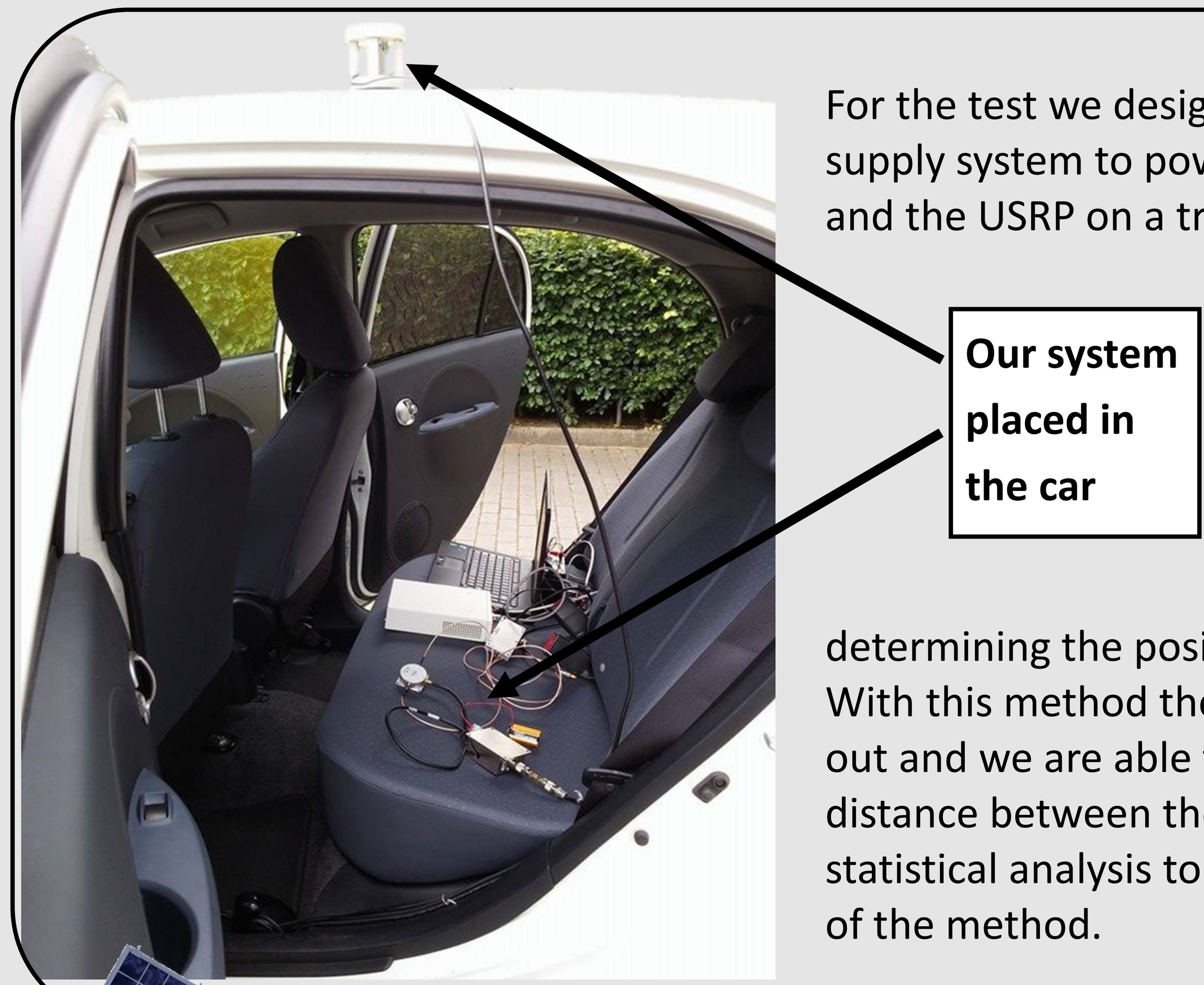
Software defined GPS receiver in a Universal Software Radio Peripheral (USRP) device

We enhance this idea by adding a dual polarization antenna designed by the Newcastle University Civil Engineering School [2] to increase signal strength. We then put the idea into practise by measuring the distance between two moving cars in real time in two different scenarios: an open airport area and a city area with high building causing extra signal attenuation to draw a conclusion on whether such system would be suitable for common use.

Aims

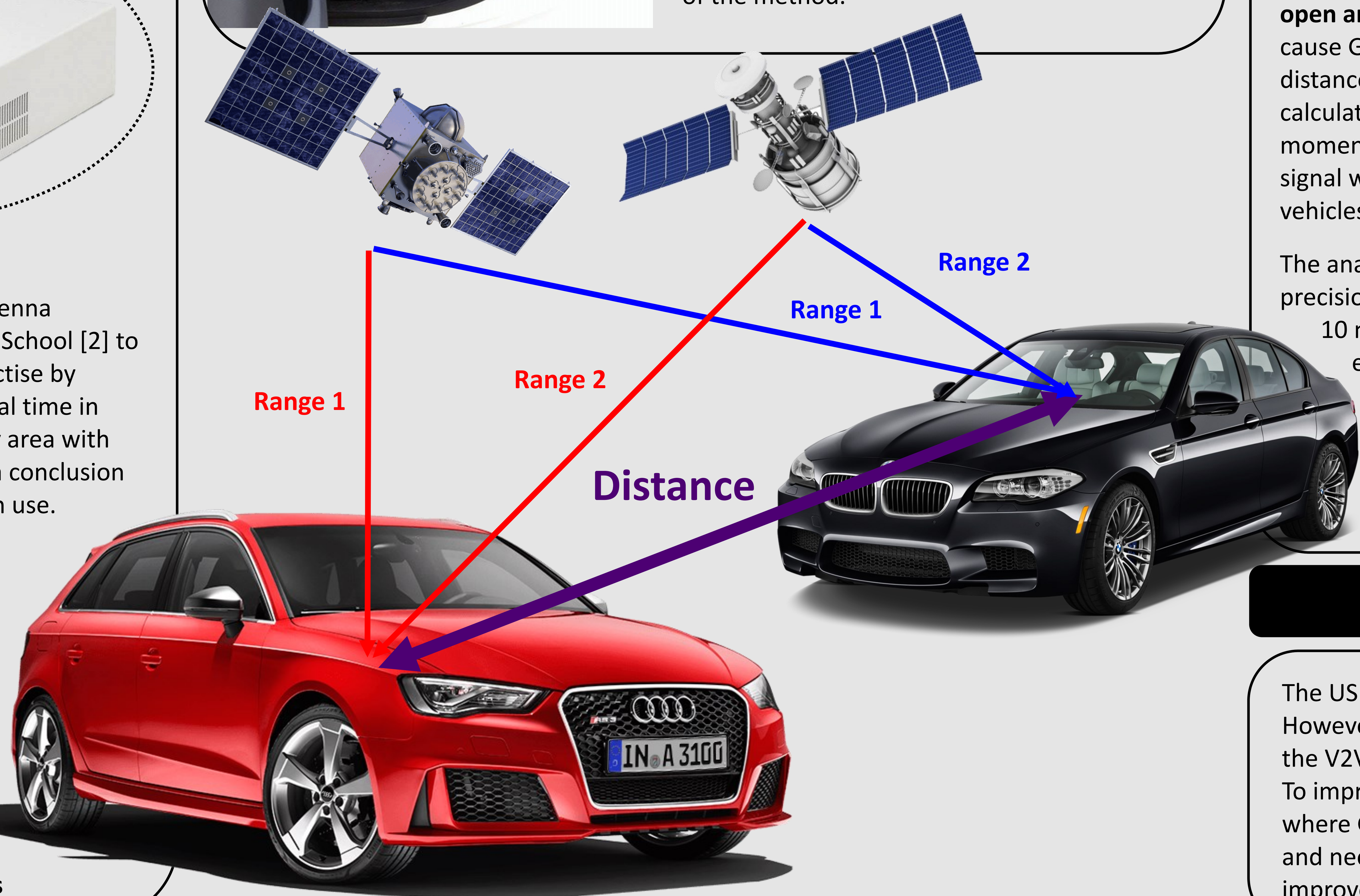
1. To build a mobile GPS receiving system using a programmable USRP kit and test it on a moving trolley around Newcastle University campus
2. **To place two such systems in two different cars and sample the GPS position data every 100 milliseconds**
3. **To analyse the sampled data to determine the precision of the distance between the two vehicles**

Method

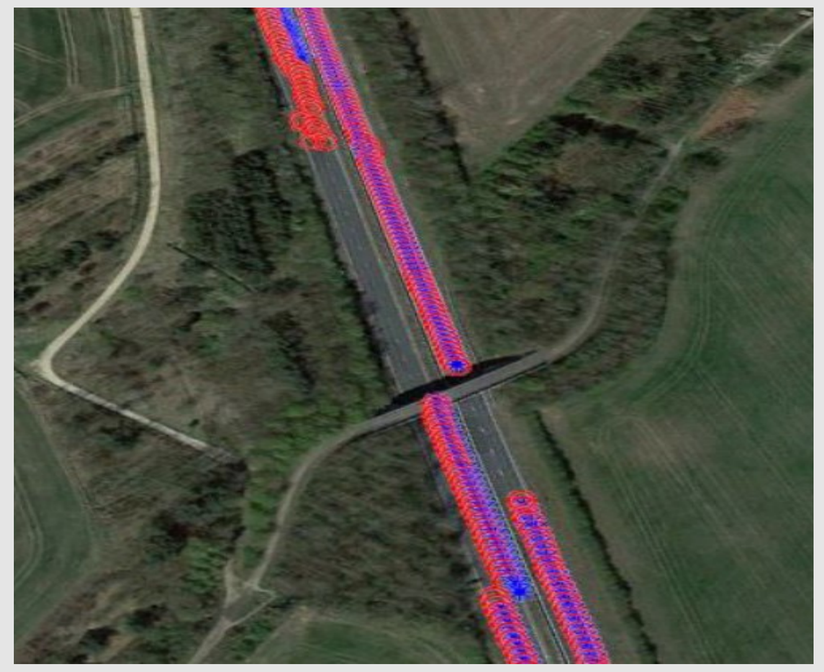


For the test we designed a mobile power supply system to power the antenna system and the USRP on a trolley and inside the cars.

We use a raw GNSS differential approach called *pseudorange double difference* method [1] that does not require fully determining the position of individual vehicles. With this method the correlated errors cancel out and we are able to obtain a more precise distance between the vehicles. We use statistical analysis to determine the precision of the method.



Results



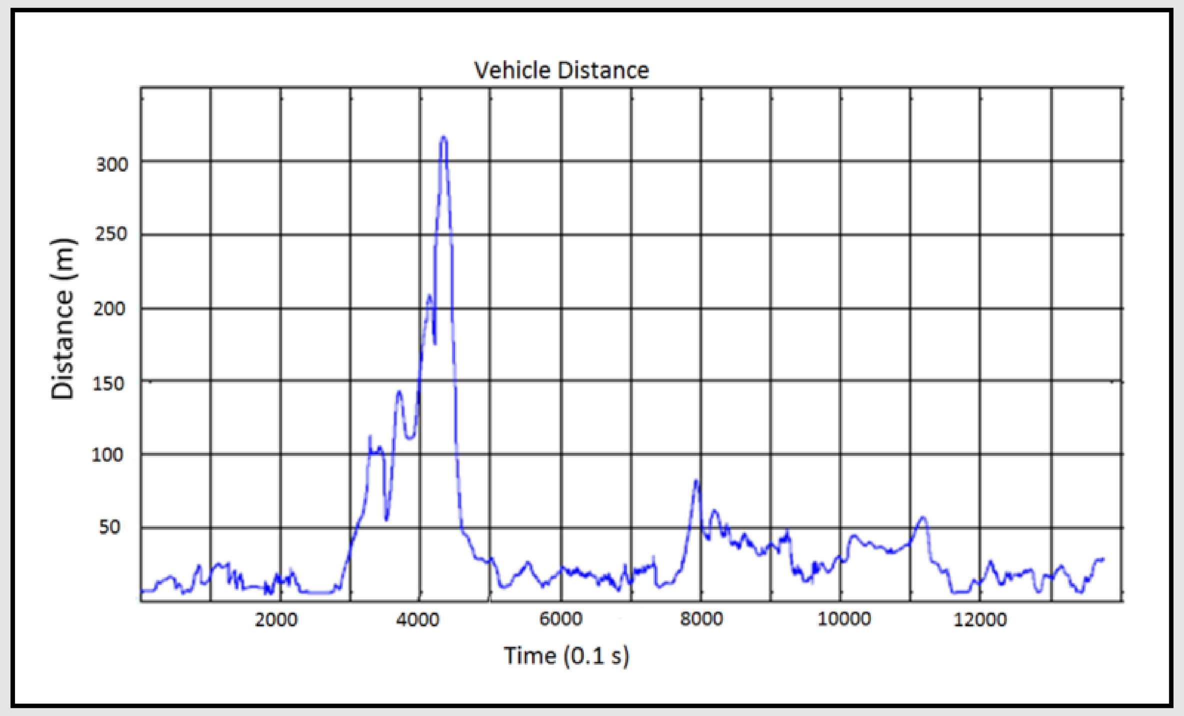
a)

b)

Received GPS at different locations by car 1 (blue) and car 2 (red)

The red and blue colour in the graphs below represent data obtained from each car from the **open area test (a)** and test in the **city (b)**. Although bridges (a) and city infrastructure (b) cause GPS signal loss, the distance of the cars can be still calculated using the data at the moments in time when the signal was received by both vehicles.

The analysis has shown that the precision of our system is about 10 m, which is not good enough to prevent collision. We are however suggesting improvements to the system that if solved, could make the system realisable.



Distance between vehicles at different times

Conclusion

The USRP has a potential research value in vehicle-to-vehicle (V2V) communication.
However the accuracy of the software based GPS receiver need to be improved in order to fulfil the V2V communication requirement.
To improve the accuracy of GPS, Road Site Unit (RSU) is proposed [3] track the position at places where GPS signal is week. The current combination algorithm of GPS and RSU is not efficient and needs to be improved. Inertial Navigation Systems (INS) would be another alternative to improve the accuracy of the GPS receiver.

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References

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