Automatic first aid in case of cardiac arrest with autonomous driving vehicle

Internet of Things

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2174 Words

1. Introduction

With the rapid growth of IT today, it has even come to the part that assists driving in automobiles. The currently applied functions mainly include various functions such as maintaining a constant speed when driving for a long time on the highway, maintaining a distance from the vehicle in front, changing lanes automatically, and preventing lane departure. Further, companies like Waymo are already piloting some self-driving taxis, and their features are getting better and better. In such a situation, if the driver faints or cardiac arrest due to low blood pressure, drivers become dangerous. At this time, the vehicle may rush or collide, causing a secondary accident. Not only pedestrians and other drivers are also at risk in this case, but also the unconscious driver is even more at risk to die. So, based on the developing autonomous driving, propose a function that automatically recognizes an emergency and reports an emergency when the heart rate drops, beats too fast, or a cardiac arrest occurs. In addition, it flashes on the hazard lights at the same time as an emergency report and stops on the shoulder to prevent secondary accidents and collisions. In addition, if there is a more advanced autonomous driving function, it checks the time to go to a hospital with an emergency room nearby, and if it is possible to arrive within 5 minutes, also suggests a function to transfer it to a nearby hospital.

2. Background

The third of the 17 goals pursued by the United Nations, Good Health and Well-being, is very closely related to the medical field that I have been interested in. Goal 3 target, 3.6 which aims to reduce traffic accident deaths and injuries by half by 2020, and in 3.7, it is written about ensuring access to quality and essential health care. It is good to help developing countries or poor countries, but these areas such as dispatching doctors, changing perceptions, and eradicating corrupt companies should be done first, rather than using electricity without proper infrastructure or IoT, which can be expensive. it is judged be So I started thinking about the environment that is medically related and I need to help patients quickly in an emergency, but it can be the most difficult to get my hands on.

Cardiac arrest can occur even at a young age, but it is more common in older people. Life expectancy has improved in the present age, where medical technology is improving, food and vitamins are abundant, and this raises the problem of aging. That is why the number of cardiac arrests while driving increases every year. In addition, the number of people who do not have enough sleep or are under a lot of stress with a lot of work is increasing (Miao 2021), and as these cases increase, the number of patients with cardiac arrest is also increasing.

In such a situation, if a person passes out due to cardiac arrest or low blood pressure, the probability of an accident such as colliding with another vehicle is very high (Box 2011). In addition, an emergency treatment for patients is very difficult in situations such as automobiles or highways, and if driving alone, there is no one around to help, so it is difficult to act within the golden time of 4 minutes in case of cardiac arrest. After 5 minutes of cardiac arrest, the probability of death increases very steeply, so it is desirable to act within 5 minutes. In fact, if the defibrillator within 3-5 minutes (Hansen 2018), chances of survival are very high. But the reality is that it is very difficult (Inamasu 2017). However, if start at the right location and within the golden time, it can get good results. This can greatly increase the driver's chance of survival (Fukushima 2021). These problems are listed in detail as follows.

1. Emergency measures for cardiac arrest while driving is difficult and difficult to recognize from outside, so it is easy to exceed 5 minutes of golden time, which increases the probability of death.
2. Even in the case of general cardiac arrest, it takes time to report an emergency. It's even worse for the driver in the car.
3. If the driver suffers cardiac arrest or loses consciousness, the vehicle may accelerate, come to a sudden stop, or turn and may hit a pedestrian, drive in the opposite direction, or collide with a vehicle in front or next to it. If the road, tunnel, or accident vehicle is a bus, a bigger accident may occur and cause great casualties.

Therefore, I propose a solution for these parts as internet of things.

Name	Usage	Kind
Car(ECU)	Move to current location, car autonomous driving	Self-driving system
Heart Rate	Check heart rate	Heart rate sensor
Data Collet Centre	Responsible for driver status identification, emergency reporting, etc.	Server

[Figure 1. Hardware and platform]

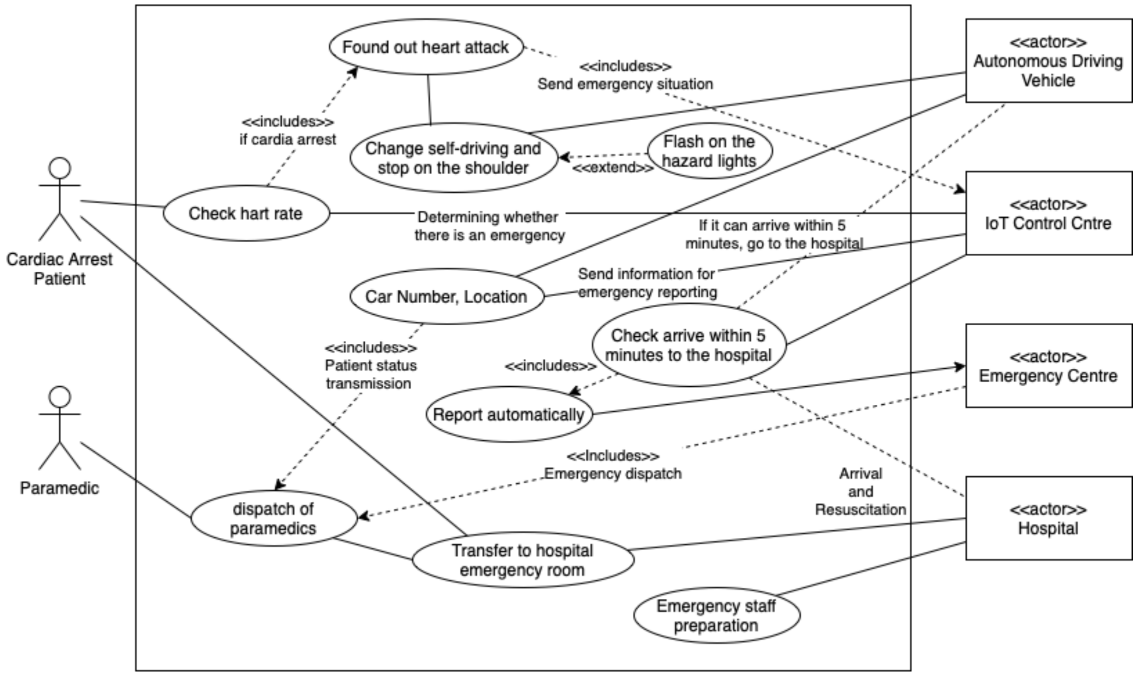
Currently, moving beyond 4G LTE communication to 5G and it spreads to IoT, it will be a hyper-connected era, so various gadgets and systems are complex but organically connected and fast information processing can occur. In addition, Mercedes-Benz obtained international autonomous driving level 3 certification from UN-R157, an organization under the United Nation on 11th December 2021, and the German government decided to approve its use based on the technical approval regulations of UN-R157. As a result, level 3 was limited to a maximum of 60 km/h, it is okay if the driver is not paying attention to driving, unlike in level 2 where the driver must keep an eye on the front or hold the steering wheel while driving. It will only be installed on the Mercedes-Benz S-Class and EQS, but it is speculated that it will soon be introduced in other models and brands. With these parts, a shoulder stops or a trip to the nearest emergency room hospital can be left to these level 3 or higher autonomous driving.

Also, a lot of people use smartwatches which is the Galaxy or Apple Watch has an accurate heart rate. Another method is to embed a device that can measure the heart rate in the car, and by attaching a sensor to the chest part of the three-point seat belt, it is possible to measure the heart rate by wearing the seat belt naturally.

3. Architecture

3-1. Use Cases

Based on what I researched in the background and planned accordingly, I wrote a use case.

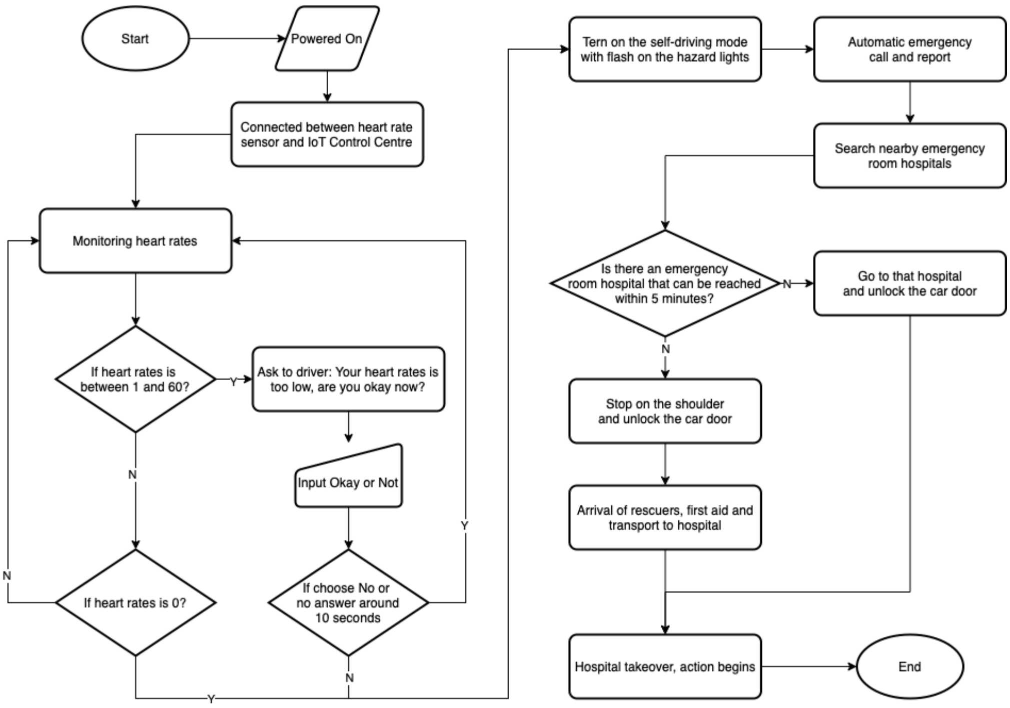


[Figure 2. Use Case]

1. Check heart rate for cardiac arrest or unconsciousness
2. In case of emergency report, vehicle registration number, current location and patient ecology are communicated
3. Release door locks and flash on hazard lights for immediate first aid
4. Check if can reach the nearest emergency room within 5 minutes, if so, go to the hospital with self-driving
5. If not, stop the car on the shoulder
6. In the case of a tunnel or bridge, exit the bridge, stop and transmit the exact location
7. Rescue team provide first aid and transported to a nearby hospital

3-2. Flowchart

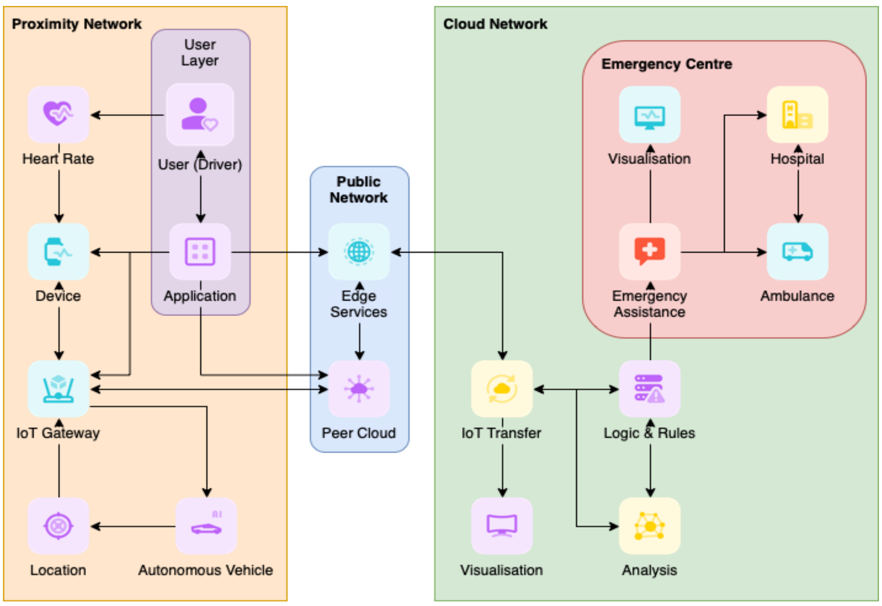
To understand the overall flow based on the use case, a flow chart was created so that the flow could be understood briefly.



[Figure 3. Flowchart]

3-3. Architecture Diagram

After grasping the structure as a use case, I designed the architecture with flowchart. It is designed with the assumption that it will actually work.



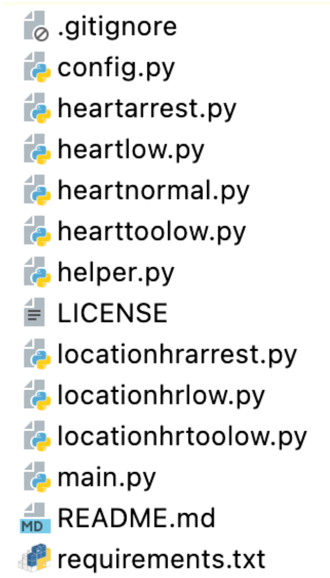
[Figure 4. Architecture diagram]

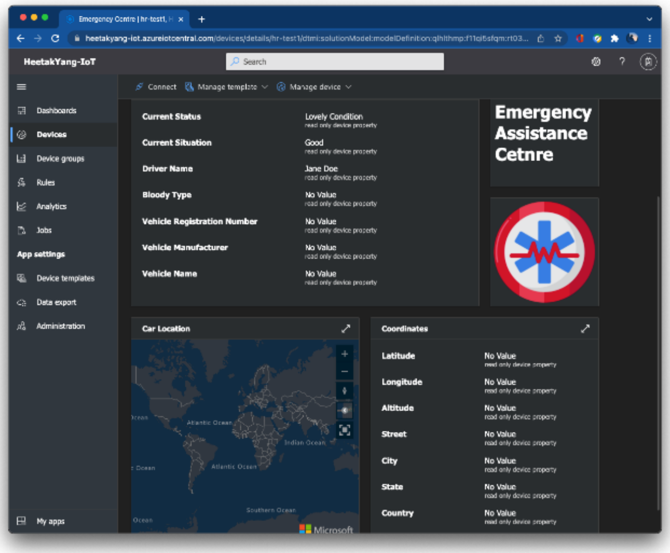
4. Prototyping

4-1. Prototype Implementation

Prototype development was very straightforward. I proceeded by discharging the results according to the heartbeat in the form of a simulation. The heart rate should be measured on the Apple Watch or the belt, but since it is a simulation, it is set to create a random value within a certain range and send it to the server. Then, for simple simulation, I made using Sample PnP of Azure IoT SDK Python. Based on this temperature measurement sample, developed it by converting it into a heartbeat simulator.

When the main file is executed, it can be executed according to the situation. In the case of the config file, set the environment settings, in the case of heart*.py, the heart rate is sent according to the situation, and in the case of locationhr*.py, the current address and information of the driver are sent according to the situation.

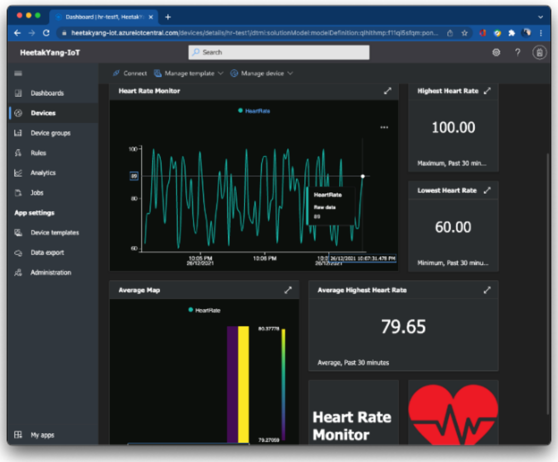




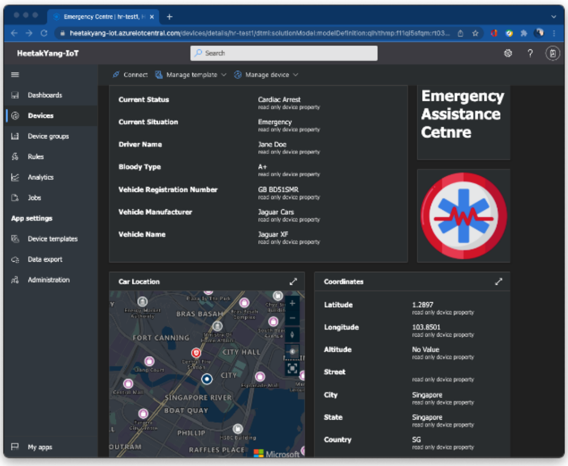
[Figure 5. File list] [Figure 6. Privacy protection]

It is possible to send the driver's information and combine it with the heart*.py, but in that case, the value is sent before recognizing an emergency, so it is separated for sequential execution later. Increasing survival rates in the event of cardiac arrest is also important, but privacy should not be compromised. To protect the driver's privacy as much as possible, values such as location and car information are not sent except for the name in non-emergency situations.

4-2. Prototype Evaluation

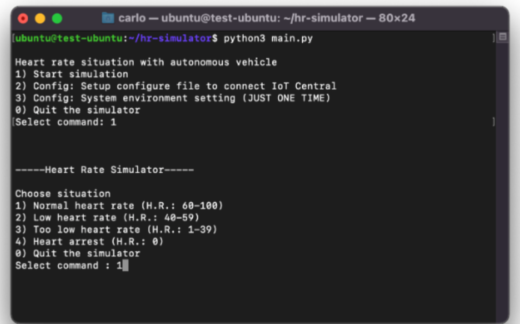


[Figure 7. Simulating normal heart rate]

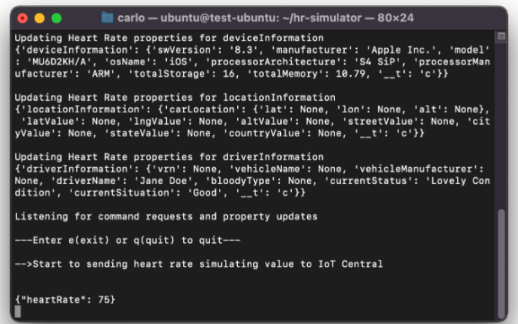


[Figure 8. Output in emergency situation]

Depending on the situation, a set value is sent. In the case of Normal, a value between 60 and 100, which is a normal heart rate, is transmitted, and in the case of Low, a value of 40 to 59 is transmitted, but the status is asked. In the case of 1-39, which is too low, it is not a cardiac arrest, but it is a number that causes loss of consciousness, so it automatically sends an emergency report, current location and driver information, and finally changes to self-driving and stops on the shoulder with flash on the hazard lights. In the case of Arrest, the same action is taken as too low, but the cardiac arrest is sent when an emergency is reported. Originally, it should have the ability to move to the nearest hospital within 5 minutes in consideration of the surrounding traffic conditions. However, it was excluded from the demo because it is used in simulations by replacing IP with location values.

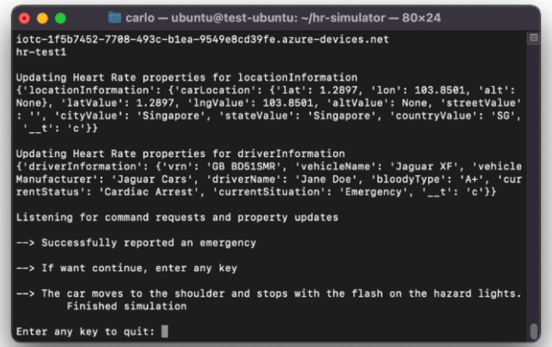


[Figure 9. Simulation control panel]

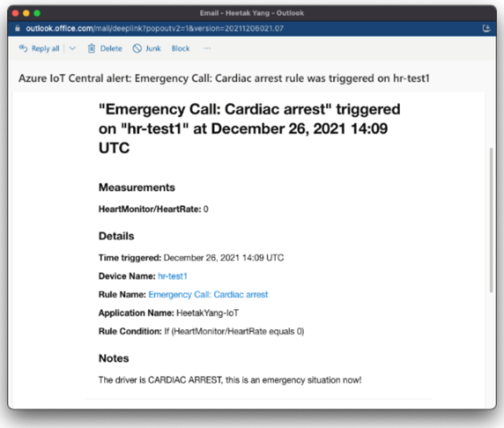


[Figure 10. Running normal heart rate]

And, in case of too low or arrest status, an email is sent notifying for an emergency. This has replaced the automatic reporting of information to the Emergency Centre by e-mail as well as automatic updates. Overall, it works well, but it is a pity that it was not completed because difficult with only IoT Central to be reported or done like the real thing.



[Figure 11. Self-driving with emergency report]



[Figure 12. Emergency report to mail]

5. Conclusion

I was trying to create home networking using IR. Therefore, I thought that it would be possible to save electricity and further reduce environmental pollution by automatically shutting down air conditioners and heating appliances. However, after I read an article that more people than I thought would die of a heart attack while driving, I turned to cardiac arrest. At the same time, Mercedes-Benz also announced and approved Level 3 autonomous driving. Moreover, with an increase in medical technology, it was judged that it is a very necessary technology, especially now that moving into an ageing society.

However, when developing a prototype, there were problems such as how to program and the value I sent and the value I received did not match, so I suffered a lot. The fact that no matter how much I searched, I couldn't find any information also made me bewildered. I solved the problem, but it is unfortunate that I did not do all the coding by myself, but I took the sample code and changed it according to my code. While using IoT Central, it was very difficult to unconditionally match the value of PaaS, but in the case of server setting, it was also found that it was convenient because it was completed very quickly. So, I think it was a good experience.

Reference

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Appendix

1. Azure IoT Central - https://heetakyang-iot.azureiotcentral.com
2. Demo Code - https://github.com/leelsey/CU-Project/tree/main/Internet%20of%20Things/IoT-Cardiac-Arrest-Self-Driving