# GLOBAL INNOVATION AWARD
# TEAM ÖÖKULLID // ESTONIA // FLL.EE
# PRAMS // POTHOLE REAL-TIME ANALYZING & MAPPING SYSTEM
# *FIRST*® LEGO® League 2019 / 2020 CITY SHAPER℠

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# PROBLEM OVERVIEW

Our problem is targeted to potholes in the streets. In Estonia where the yearly and even daily temperature amplitude is big (somedays it’s over 10℃ of amplitude in a day) it isn't a rare coincidence to run into (or over) potholes. There are mainly two ways how potholes affect us.

1. Potholes damage the vehicles driving on the streets.
2. The dust from the potholes damages our health.

Our team chose this problem because in Estonia potholes are fairly common and in the modern world it’s a relevant topic, especially in big cities. Also there aren’t any solutions to automatically find and map potholes, which leads to them getting bigger, doing more damage to humans and vehicles and being more expensive to repair.

# SOLUTION DETAILED DESCRIPTION

Our solution is PRAMS - Pothole Realtime Analyzing & Mapping System. PRAMS uses an accelerometer to measure the oscillations a vehicle makes when driving through potholes. The bigger the oscillation, the bigger the pothole. The GPS sensor records the exact location where the oscillation took place and sends that info to the microcomputer control unit in the vehicle. From there the data is sent in real-time through 5G internet network to the central server, there all the gathered data is compared and the computer makes a map of where the oscillations appeared.

We use 5G internet because it is 100 times faster than 4G and through 5G internet network you can send data in real-time which makes mapping the pothole locations a lot easier. We would attach it to the control arm of the vehicle. This would allow us to get precise data on the location where the potholes are detected. The map would be used by companies that repair potholes. It would allow them to react to the potholes faster and repair them before the potholes can get big and cause more damage to vehicles and humans.

# INNOVATION

Our solution RPAMS can gather data more precisely than any other solution. There are a lot of studies done on the accelerometers in Android smartphones and they tried to use those to locate the potholes however since the car moves a lot, measuring from the phone wouldn't give precise data. It also depends on what way your phone is and it needs to be stable or else any data it gathers can be false. There are a lot of apps and websites on the market where people themselves can report potholes they find or gather data while driving. One such app is called Street Bump, it is being used in Boston and the data it gathers is sent to the city of Boston government. To use the app you need to start a drive in the app when you begin driving and end the drive when you stop driving, after this the app will calculate all the spots where oscillations appeared. The problem with those apps are that touching the phone during driving could also cause the phone to register oscillations. Also, if someone were to call you it would cancel the drive and you can't use navigation apps such as Google Maps while using Street Bump. Those apps are also available only in certain regions (like Boston). Lastly, these apps heavily rely on people downloading the app and starting a drive, which many don't do.

# SOLUTION DEVELOPMENT

At first we wanted to use a laser to locate the potholes but we couldn't figure out where we would attach the laser to and it would give inaccurate data because the laser would move with the car when a pothole appears in the road. We decided on using an accelerometer to find potholes because it gives accurate data and we can send that data in real-time. We wanted to use our system on cars at first but during our research, we found out that every car is different so every car would give us different data because of the way they were built and also older cards aren't as stable as newer cars so they would give very different data. That's why we decided on putting the system on public transport. Public transport drives around the city every day anyway so we thought that we could make it even more useful and find potholes on the main roads that public transport drives through. In most cases a city uses the same type of vehicle for public transport so putting the system on multiple buses, trolleybusses, etc would give the same data. Public transport vehicles also get more maintenance checks so attaching the system and configuring it when needed will be easier to do and save a lot of money. We attach the system to the control arm of the vehicle because that detects the potholes, putting it anywhere else in the vehicle wouldn't give accurate data because of the suspension in the vehicle.

# IMPLEMENTATION

We've divided the cost into three categories:

1. Materials and sensors.
2. First-time setup (programming etc)
3. Regular maintenance

The cost of materials and sensors is about 20 USD. The costliest is the GPS, which is about 13$, the second-costliest is the accelerometer, which is about 5$. The remaining cost is dedicated to the materials.

The first-time setup is about 40.000$, the main cost here is programming the system and the UI.

Regular maintenance is about 1000$ per month, the main cost there is maintaining the central server, which collects the information from the PRAMS and analyzes it.

For the information from the sensors to reach the central server, we use 5G. 5G is a new innovative technology, which is superior to 4G in many ways, mostly in speed.

To connect PRAMS to the network we reached out to Metrotec and Carcos, companies who remotely monitor cars using the internet among other things, to work with them and to use some of their parts to build our system.

# DESCRIPTION OF INNOVATIVE SOLUTION IN FIVE (5) WORDS OR LESS

Pothole Real-time Analyzing & Mapping System.

# TEAM DESCRIPTION

We’re team “Öökullid” from Tallinn, Estonia and we all study in Tallinn Kristiine High School (Tallinna Kristiine Gümnaasium). Our team is named “Öökullid”, which means “The Owls” in Estonian - the owl is also our school mascot. Team Öökullid was created in 2010 and has kept the name unchangeable since then.. Some of us are part of the 3rd and some 4th generation of “Öökullid”. The 1st generation of Öökullid study in university already, but the 4th generation is still in 5th grade. Our team has our coach Lauri “Öökullipapa” and 10 members: Adrian, Aleksander, Hugo, Johannes, Joonatan, Sander, Sebastian, Silver, Oliver and Oskar. We all go to the same school but we are in different grades. The team’s name comes from our school’s mascot, the owl. As a team you can describe us as night owls because we like to work on and improve our robot and innovation project until it is late in the day when the school is already closed.

# BRIEFLY DESCRIBE THE TOP THREE (3) THINGS ABOUT YOUR TEAM

1. We are very friendly and always have fun.

   We are very friendly because we always help and support each other and other teams, we also take care of the younger ones, help them understand what to do and how to do it. When we are in robotics we always have a tremendously good time there because we always make fun of things and laugh from the heart.

2. We have a mentor system.

   At the beginning of the year a new generation joined us. We decided that the best way to teach them the basics of robotics is to give each of our a bit more experienced team members a newbie to integrate into their robotics activities. It has worked out phenomenally.

3. The Owls- by the name and by the heart.

Our team name is “Öökullid” (the Owls) which comes from our schools mascot, but in real life we can be described also as night owls because we like to work on and improve our robot and innovation project until it is late in the day, when it already gets dark outside and we leave our robotics club not until the security guard wants to close the building.

# PUBLIC INNOVATIVE SOLUTION DESCRIPTION

Our solution is PRAMS - Pothole Realtime Analyzing & Mapping System. PRAMS uses an accelerometer to measure the oscillations a vehicle makes when driving through potholes. The bigger the oscillation, the bigger the pothole. The GPS sensor records the exact location where the oscillation happened and sends that info to the microcomputer control unit in the car. From there the data is sent in real-time through 5G internet network to the central server, there all the gathered data is compared and the computer makes a map of where the oscillations appeared.