NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020

EIROPAS SAVIENĪBA

Eiropas Jūrlietu un zivsaimniecības fonds

„Paplašinātās funkcionalitātes lieljaudas zemūdens akustiskā raidītāja izstrāde roņu nodarīto postījumu samazināšanai Latvijas piekrastes zvejā"
Nr. 16-00-F01101-000001

Zemfrekvences akustiskais raidītājs

Asoc.prof., dr.sc.ing. Dmitrijs Pikuļins
Radioelektronikas institūta direktors

30.11.2018

1862
RTU
ELEKTRONIKAS UN TELEKOMUNIKĀCIJU FAKULTĀTE

Projekta mērķis

Inovācija zvejniecībā, izstrādājot ieviešanai ievērojami uzlabotu aprīkojumu.

Projekta ietvaros tiek plānots izstrādāt paplašinātās funkcionalitātes lieljaudas zemūdens akustisko raidītāju (ZAR) roņu atbaidīšanai no zvejniecības rīkiem.

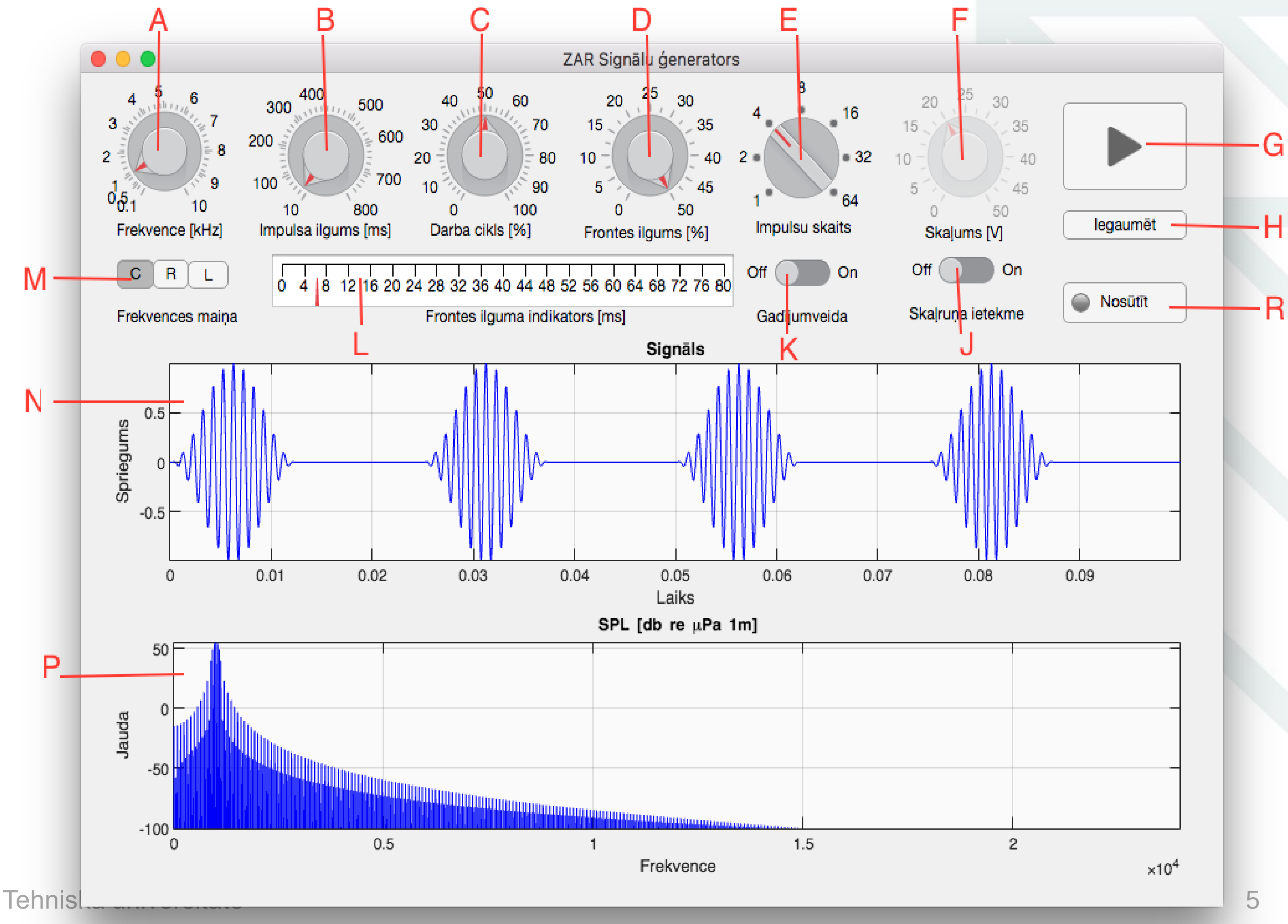
Projekta Inovācijas Apraksts

Inovācija

Projekta izstrādājamai iekārtai piemīt sekojošās priekšrocības, salīdzinot ar analogiem:

- Ģenerējamo akustisko signālu uzprogrammēšanas iespējas: efektīvāko signālu izmantošana, ietekmes samazināšana uz citiem jūras iemītniekiem.

Inovatīvie signāli



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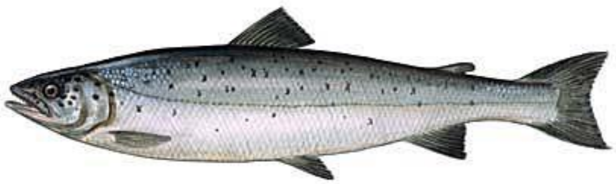

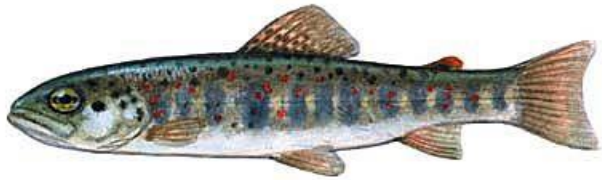

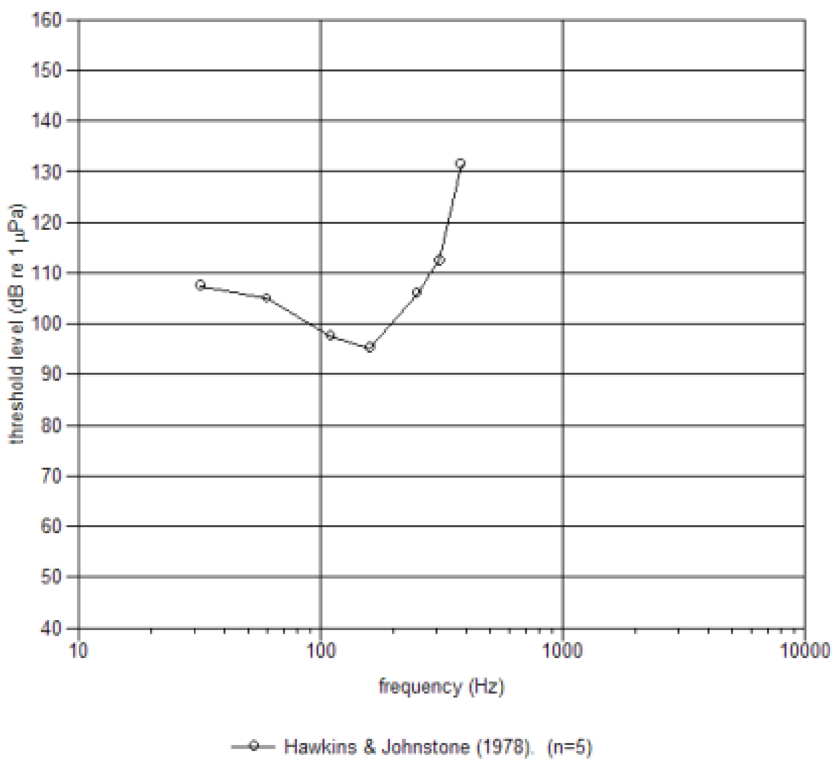

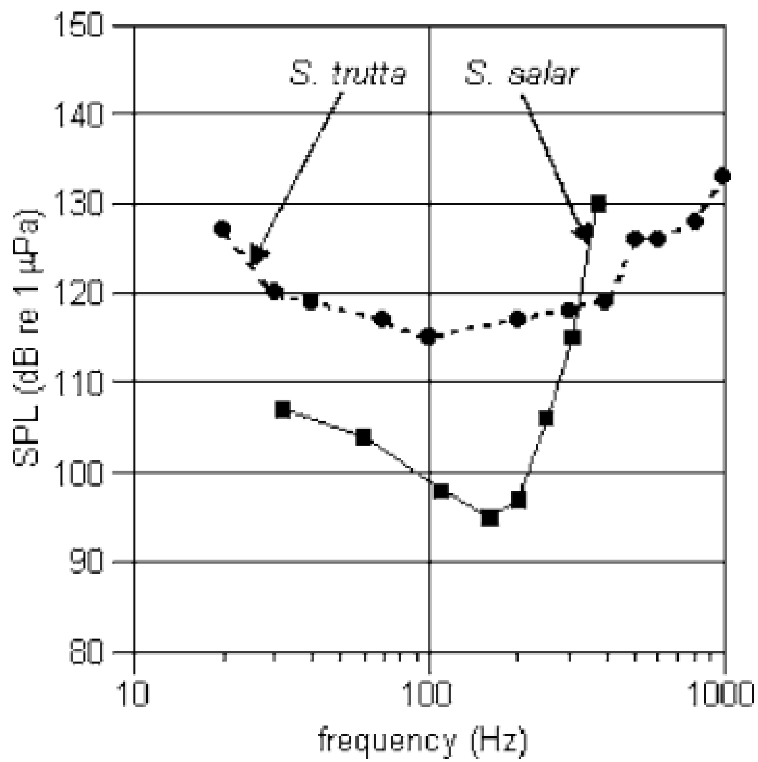

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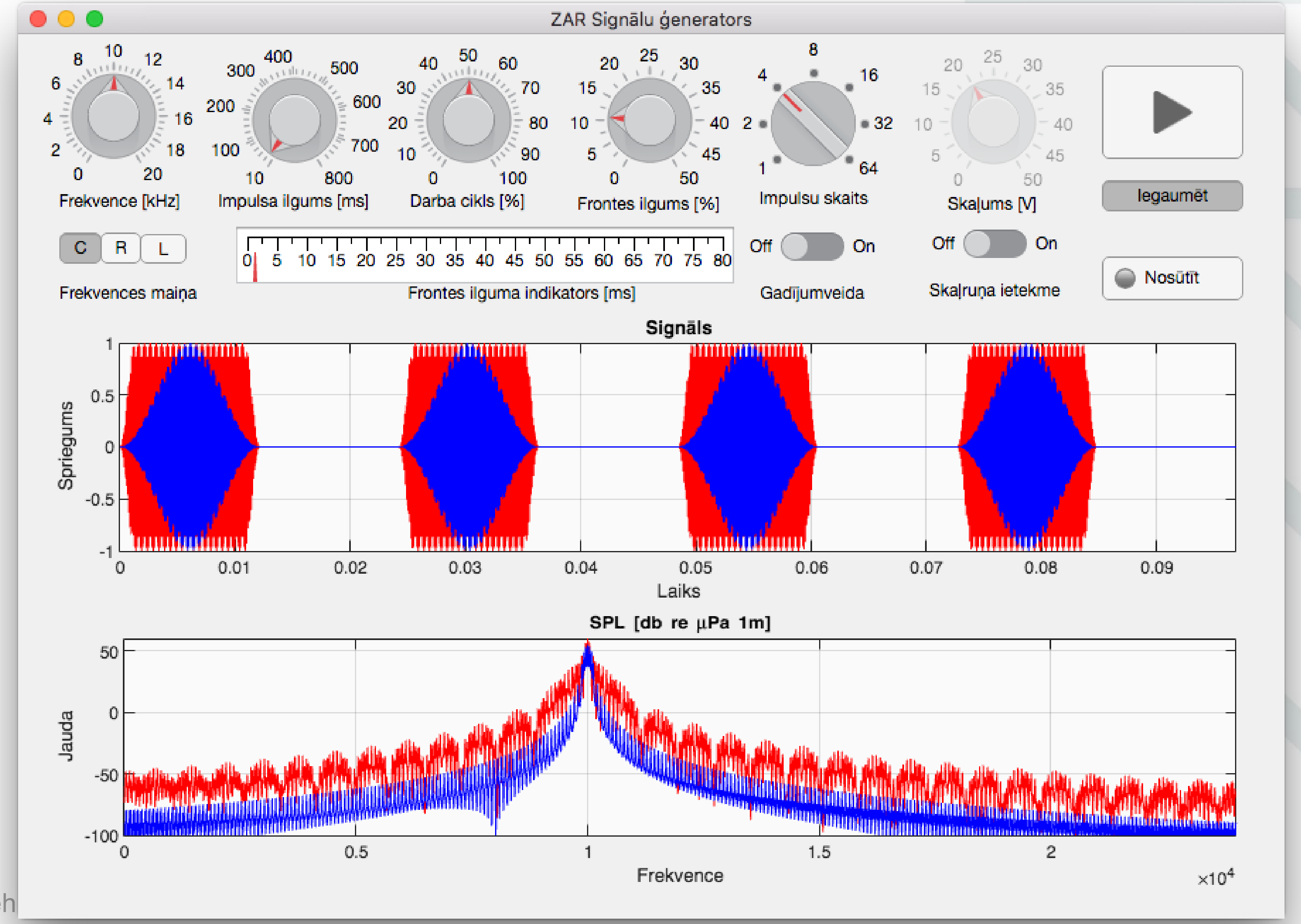

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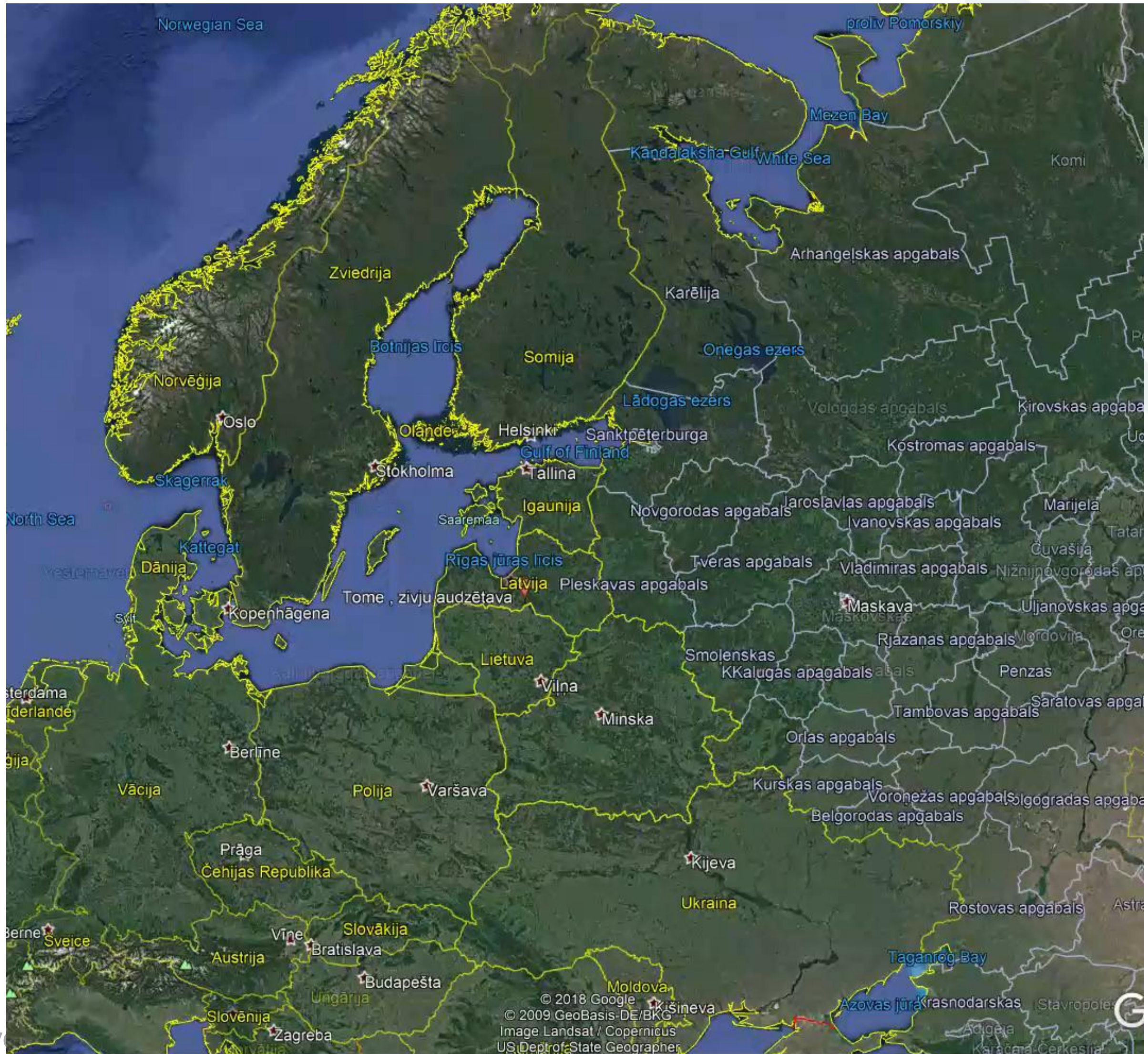

Inovatīvie signāli

Inovatīvie signāli

http://dx.doi.org/10.5755/j01.eee ELEKTRONIKA IR ELEKTROTECHNIKA, ISSN 1392-1215, VOL. XX, NO. X, 20XX

Design of acoustic signals for a seal deterrent device

Arturs Aboltins, Juris Grizans, Dmitrijs Pikulins, Maris Terauds, Maris Zeltins
Institute of Radioelectronics, Riga Technical University,
Azenes St. 12, LV-1048 Riga, Latvia
aboltins@rtu.lv

[1]*Abstract*— **During the last decade, attacks by grey seals on fishing nets in the Baltic Sea have caused considerable loss of fish catch and damage to fishing gears. One of the approaches to reduce the number of seal attacks on fishing nets is to use acoustic deterrent devices (ADDs). Unfortunately, most of the commercially available ADDs are not well suited to the deployment in the sea and require considerable additional investments. The objective of the present research is to develop a compact and cost-efficient ADD for deployment in sea environment. This paper is devoted to the design of acoustic signals for a prototype ADD. Signals from other experimental and commercially available ADDs are studied and compared. Moreover, limitations imposed by underwater environment, transducers, battery power and fish hearing are analyzed and taken into account during development of signal patterns. The results of tests conducted in an artificial reservoir and in the sea are presented.**

Index Terms— **Seals, Acoustic wave, Signal design, Signal synthesis, Underwater acoustics, Acoustic applications, Acoustic measurements, Underwater communication, Software algorithms.**

I. INTRODUCTION

An urgent problem facing the Baltic coastal fisheries in the last decade is the rapidly growing number of grey seals in the Baltic Sea. Animals, in search of food, are gaining new territories and damage fishing nets and gears leading to almost complete loss of catch. On the other hand, the grey seal and other seal species are indigenous and specially protected species in the Baltic region whose protection is simultaneously required by the so-called Habitats Directive and the Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM).

One of the most effective solutions for the reduction of the losses caused by seals is to use an underwater acoustic deterrent device (ADD), which allows to keep seals away from fishing nets. Research [1] describes the impact of ADDs on the reduction of damage to fishing in the Baltic Sea due to seal activity. Authors of this paper have made several conclusions about the efficiency and side effects of commercially available seal scarers. Most notably, it was concluded that using of ADDs leads to a noticeable reduction in damage caused by seals. However, authors noted the need for hardware improvements to make an ADD more secure and easier to use.

Many of the existing devices were developed 10–15 years ago, at a time when the question of repelling seals was not yet actively in the focus of researchers' attention. Since then, a number of important studies have been carried out that assess the effects of various signals on seals and other marine species. However, ADDs that are not modified for years (but are still for sale) do not allow the user to modify signal parameters according to new discoveries and scientific evidence, and continue to send ineffective signals to deter seals from fishing nets, thus affecting the life of other marine inhabitants.

Whereas most of the commercially available devices are well suited for fish farms, using them in the sea requires substantial investments in mechanical components and waterproof power supplies. Moreover, in an ideal case, acoustic signals used for deterring seals must be adjustable for the battery level, sound propagation conditions, transducer, and fish species.

Keeping these limitations and requirements in mind, our group of researchers have developed an advanced ADD for using in the sea. This paper is devoted to the design of acoustic signals used in a seal scarer device.

II. REVIEW OF EXISTING ADDS

At first, we will provide a short introduction into used terminology regarding acoustic signals.

Sound pressure level (SPL) L_p level is a logarithmic measure of the effective of sound pressure P relative to a reference value $P_0 = 1\mu\mathrm{Pa}$:

$$L_p = 20log_{10}\frac{P}{P_0} \quad (1)$$

The sound exposure level (SEL) describes the impact on a living creature caused by a sound with a given SPL L_p and duration τ:

$$L_E = L_P + 10log_{10}(\tau) \quad (2)$$

As we see, exposing the organism for 10s to sound gives the same result as exposing it to a 10dB stronger sound for 1s.

Research [2] provides a comprehensive review of applications of ADDs, their efficiency and environmental impact. Authors review several commercially available

[1]Manuscript received November XX, 20XX; accepted April XX, 20XX.

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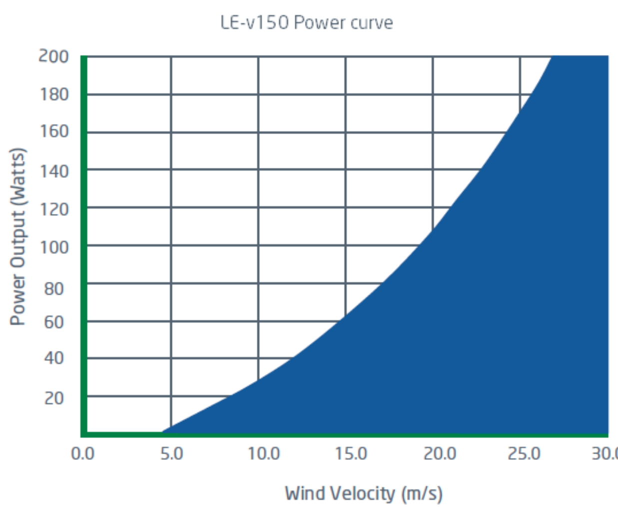
Inovācija

Projekta izstrādājamai iekārtai piemīt sekojošās priekšrocības, salīdzinot ar analogiem:

- Adaptīvs algoritms barošanas resursu efektīvai izmantošanai.

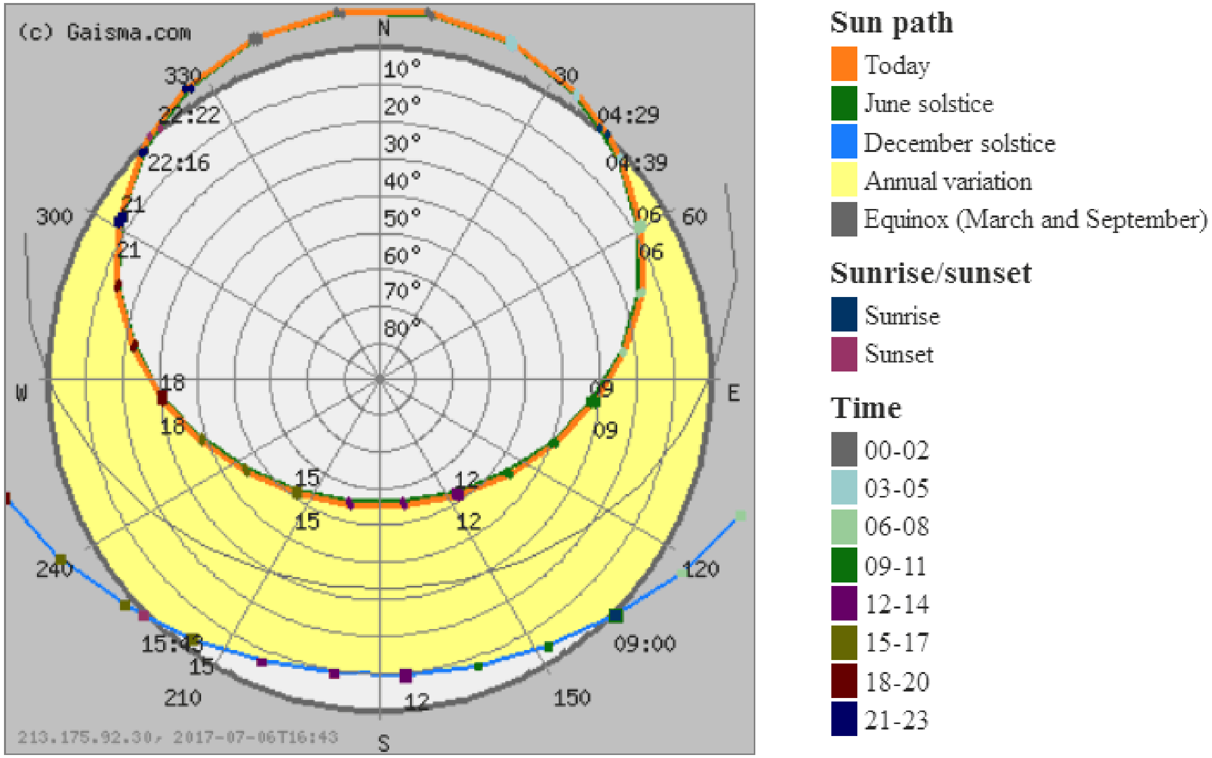
Aktivitātes

Alternatīvās enerģijas avoti: vēja ģeneratori



Aktivitātes

Alternatīvās enerģijas avoti: Saules paneļi



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Using solar power in an acoustic deterrent device for seals

Maris Terauds, Maris Zeltins, Arturs Aboltins, Dmitrijs Pikulins, Juris Grizans
Faculty of Electronics and Telecommunications, Riga Technical University
Azenes 12, LV-1028, Riga, Latvia
e-mail: maris.terauds@rtu.lv

Abstract—**The paper it devoted to evaluation of possibilities of autonomous powering of an acoustic deterrent device in the sea using solar battery. The energy harvested from solar power panels is calculated for Latvian climatic conditions. Direct and diffuse sunlight intensities are analyzed. We calculate the intensity of light for different panel placement models and show which placement is better suited for Latvian conditions. We also calculate the optimal area of solar panel suitable for powering acoustic deterrent device.**

Keywords—*solar panels, sea mammal scarer, solar energy.*

I. Introduction

In Latvia, the traditional coastal fishing plays an important role for the local communities. The Baltic Sea is rich in fish. But the increasing population of grey seals causes losses for fishermen and sometimes makes this business less appealing. Instead of catching fish in the Baltic Sea, seals make it simpler by attacking fyke nets full of fish. They bite a lot of caught fish and make them useless for futher sale. The nets are being damaged as well. One of the possibilities how to fight off seals is to use an acoustic deterrent device (ADD). A lot of studies show the effectiveness of using ADD to scare off seals (see e.g. [1], [2]).

In order to reach the mitigation effect, an ADD must be always on. It takes a lot of power – approximately 100 W during short (10 ms to 100 ms) time intervals and is then idle for 10 s to 1 min [3]. A scarer is installed near a fyke net approximately 500 m from the coast. It is possible to use powerful lithium accumulators for 3 to 6 days of autonomous operation. In this paper we analyze the suitability of solar batteries as main or auxiliary energy source for a ADD to operate autonomously and unattended in weather and terrestrial longitude conditions of Latvia. The period of interest for using a ADD is from March through October.

II. Specification of Latvian Weather Conditions

The position of the Sun in the sky is described with its azimuth ϕ_s and elevation θ_s angles. The azimuth angle is the angle between the projection of Sun's rays on the Earth and the direction to the North. It increases clockwise. The elevation angle is the angle between the direction to the Sun and the horizonal surface. These angles are dependent on the geographical location, date and time. From [4], [5], [6] we can get the solar trajectory and these angles for any geographical location. All calculations used in this research are done regarding a small fishing town Carnikava, located at 57° 08' North latitude and 24° 17' East longitude. For effective placement of a solar panel we need to know the ranges of azimuth and elevation angles. Table I summarizes these values for the 15th date of each month of interest. The Sun reaches the maximum elevation when the azimuth is equal to ϕ_s=180°.

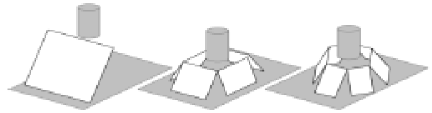
For example, we can see that, in June, the azimuth ϕ_s changes from 41.9° to 316.7°, but in October ϕ_s changes from 105.3° to 253.0°, while the maximum Sun elevation in June is 56.2° , but in October 24.3° .

TABLE I. AZIMUTH AND MAXIMUM ELEVATION OF THE SUN IN CARNIKAVA .

Month	Azimuth of the Sun ϕ_s at sunrise and sunset, degrees	Maximum elevation of the Sun θ_s (ϕ_s=180°), degrees
March	95–266.5	30.8
April	71.6–287	42.7
May	53.1–307.3	51.8
June	41.9–316.7	56.2
July	47.8–312.6	54.4
August	64.2–296.8	46.9
September	84.5–276.2	35.9
October	105.3–253.0	24.3

Because of such a broad azimuth range, we can intuitively suggest that a fixed solar panel would be ineffective. Using of a tilted and rotating panel following the Sun may be much more effective. However, in the sea, such a complex mechanism would be unreliable and difficult to control. Therefore, it is suggested to place a solar panel in a fixed position, without complicated tilted and rotating mechanisms as shown in Fig. 1 (a). An intuitively better configuration with multiple solar panels is shown in Fig. 1 (b) and (c). Then probably at least one of the panels is optimally positioned towards the Sun. In this paper we will calculate and compare the efficiency of mentioned solar panel placements.

We describe the panel orientation using the azimuth and elevation angles ϕp and θp. To define these angles, we use the normal to the solar panel. The azimuth ϕ_p is the angle between the projection of the solar panel normal on the



a. b. c.

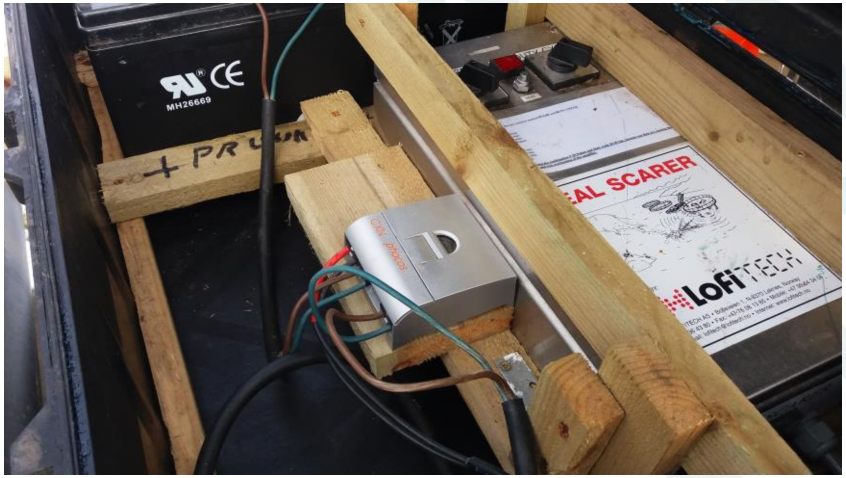
Fig. 1. Ways to place a solar panel in a fixed position: a. one solar panel, b. four solar panels, c. six solar panels. (The cylinder in the center is a place for a hypothetical wind generator).

Inovācija

Projekta izstrādājamai iekārtai piemīt sekojošās priekšrocības, salīdzinot ar analogiem:

- Konstrukcija pielāgota Latvijai raksturīgām piekrastes zvejas īpatnībām (15m dziļums, atklātā piekraste).

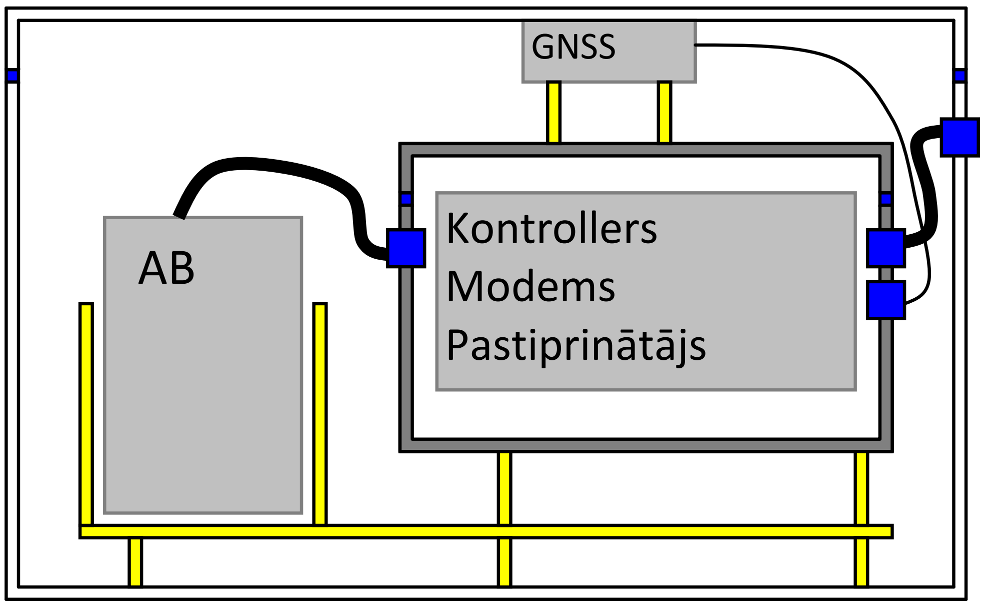
Plosts

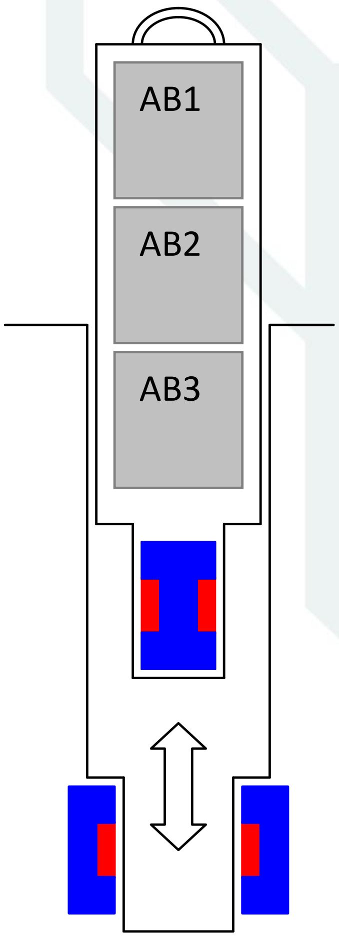


Plosts

Aktivitātes

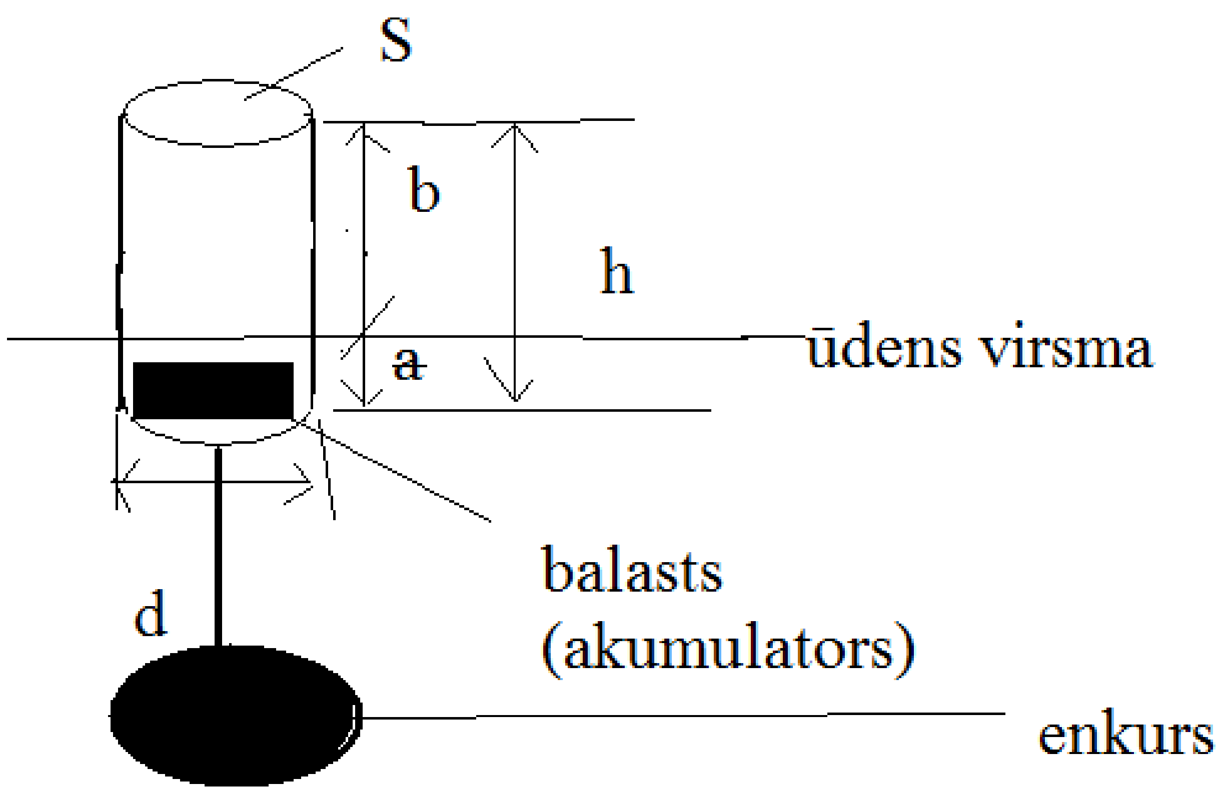
Korpusa izstrāde





Aktivitātes

Korpusa izstrāde



Aktivitātes

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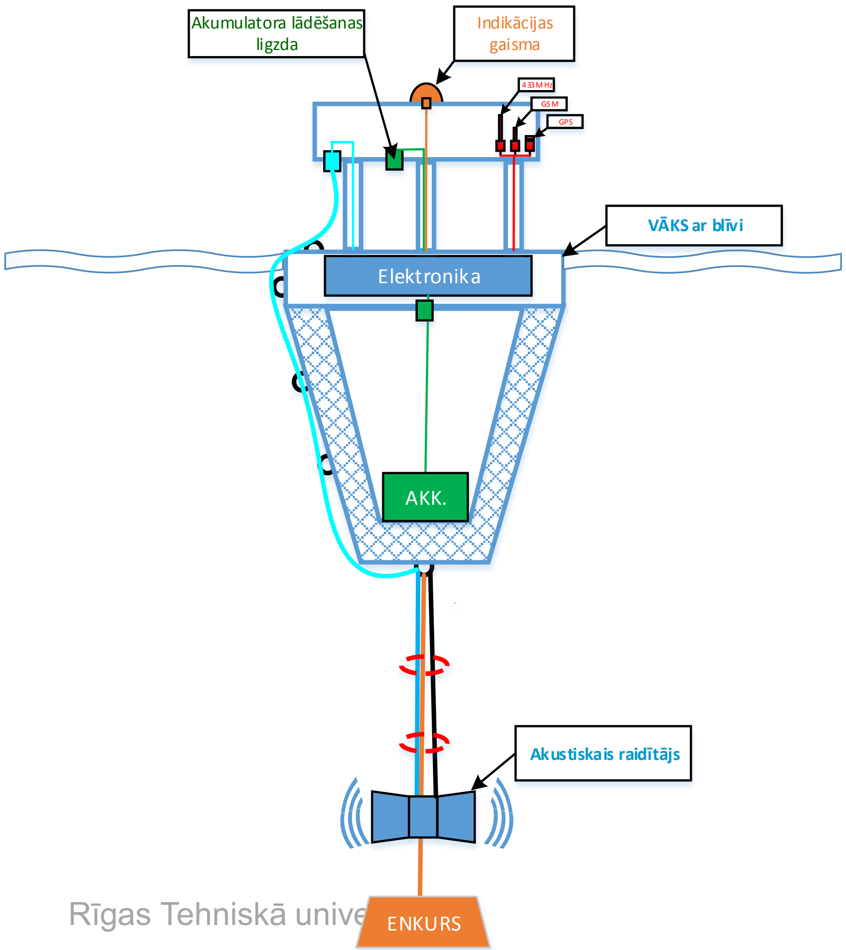

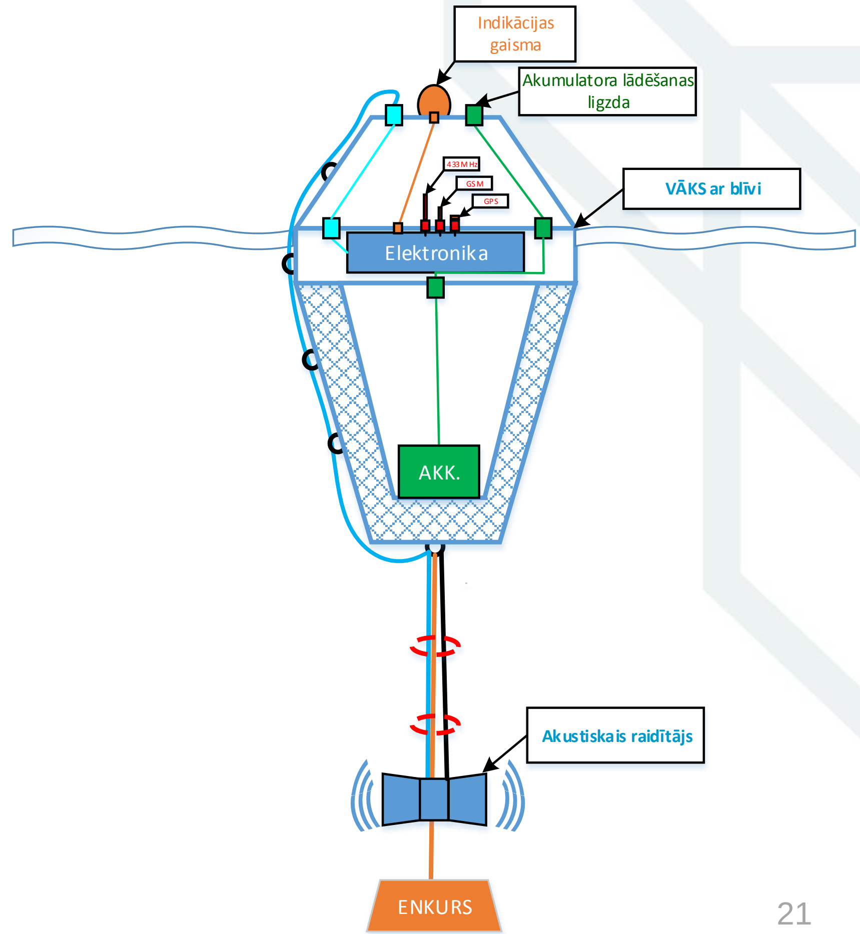

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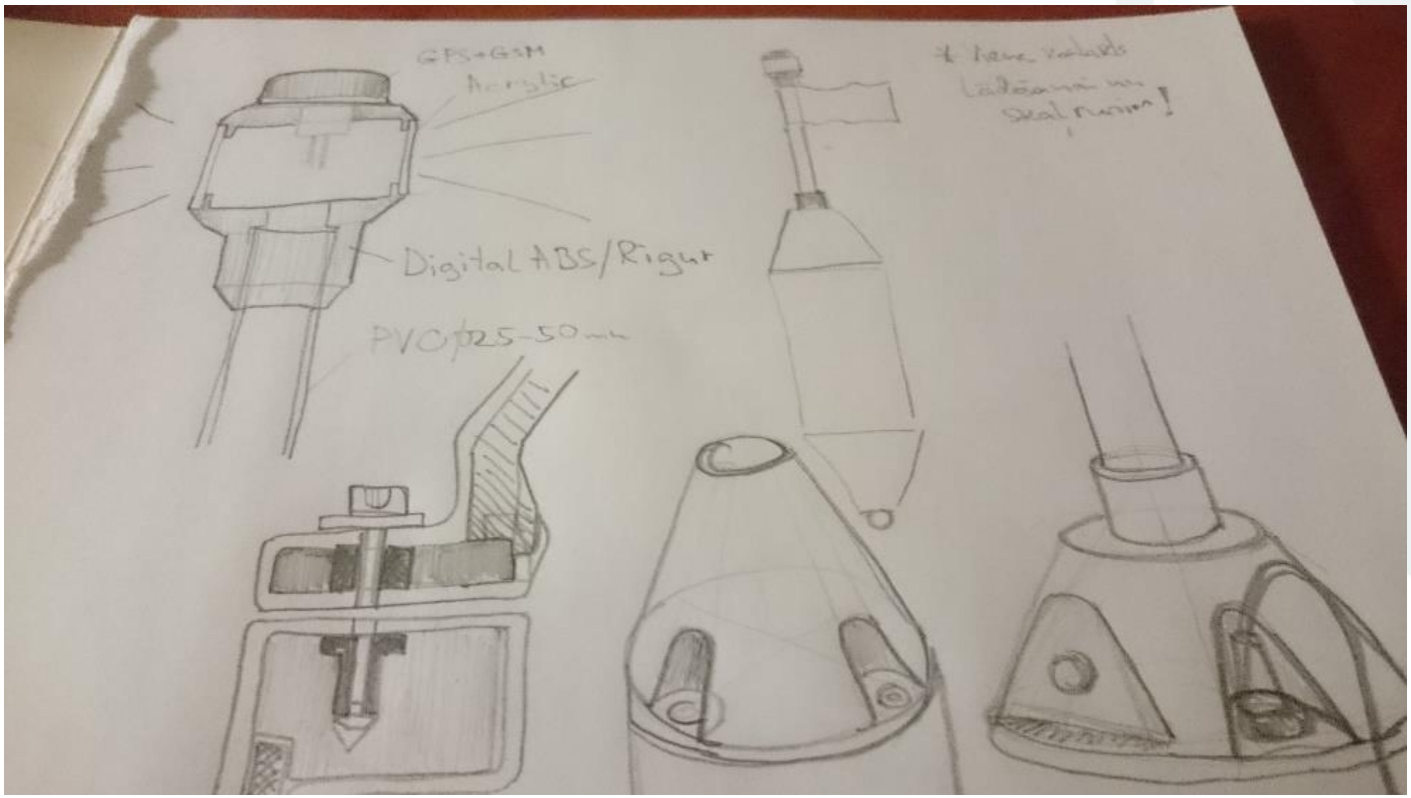

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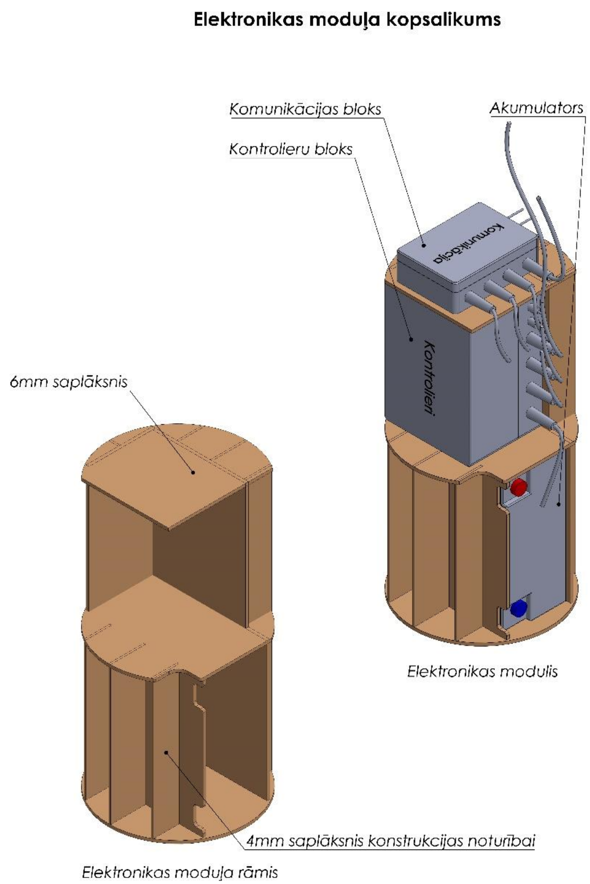
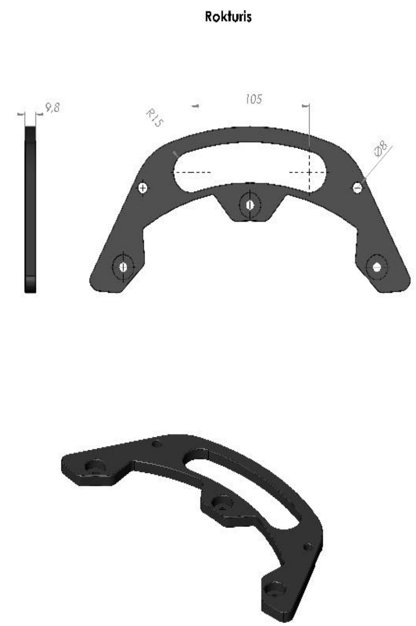
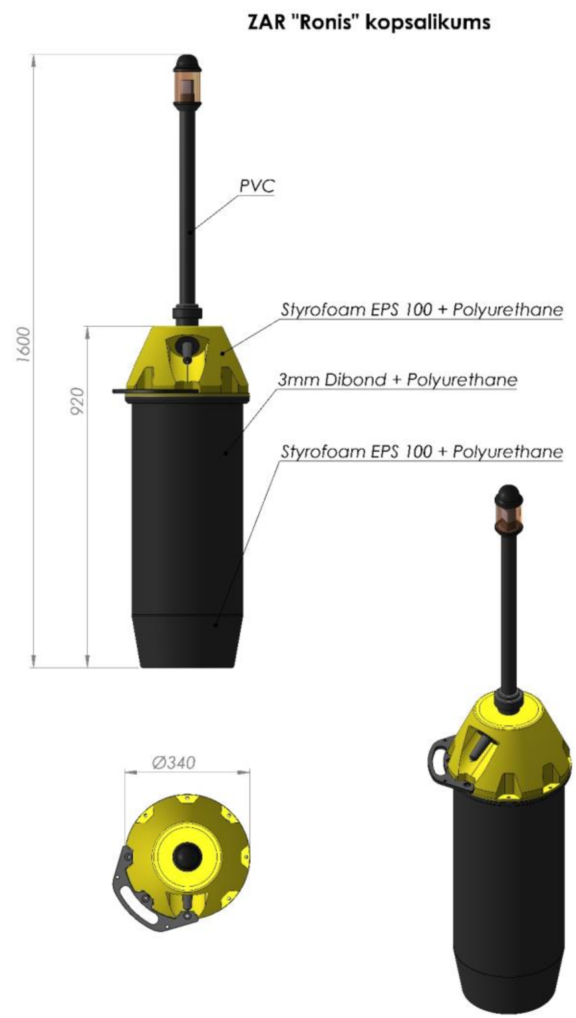




Aktivitātes

4. Korpusa izstrāde



Aktivitātes

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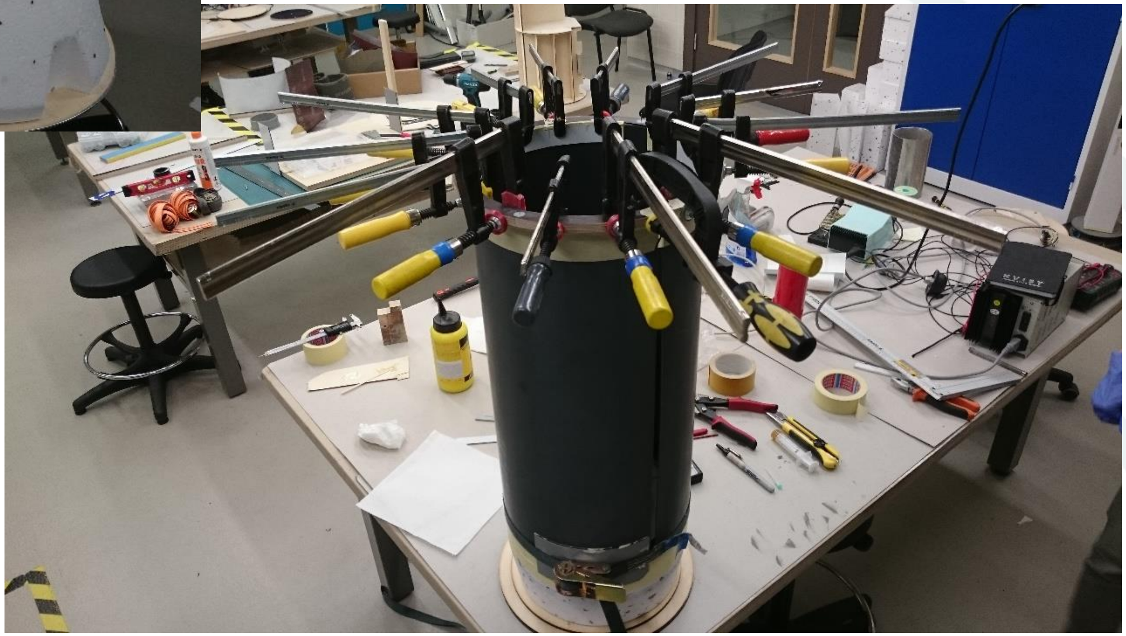

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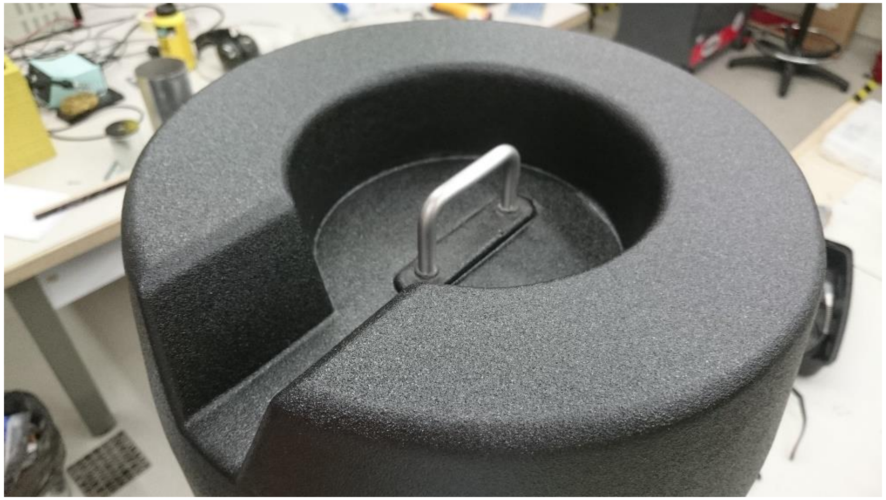
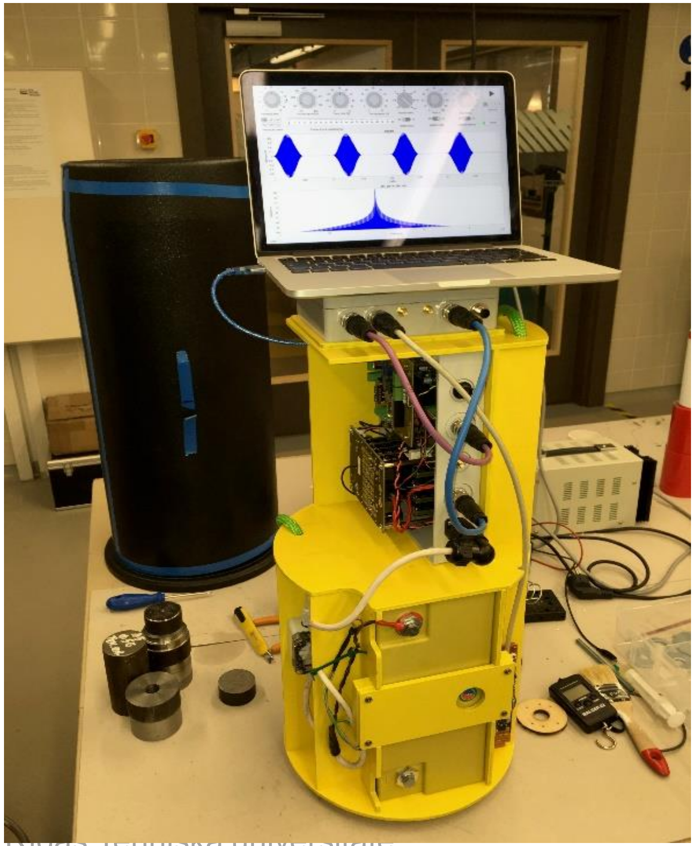
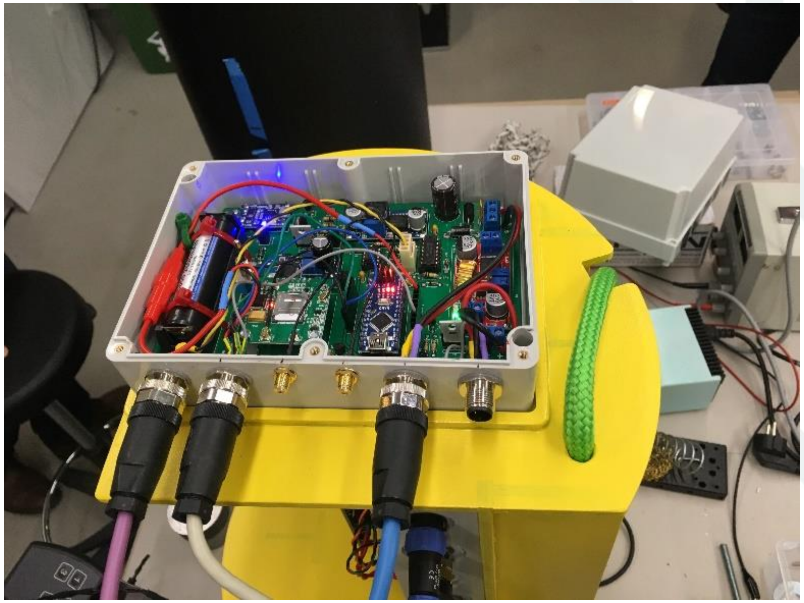


Aktivitātes

Laboratorijas testēšana





Inovācija

Projekta izstrādājamai iekārtai piemīt sekojošās priekšrocības, salīdzinot ar analogiem:

- Bezvadu interfeiss diagnostiskās informācijas attālinātai nolasīšanai. Potenciālā iespēja veidot sinhronizētus raidītāju tīklus.

Aktivitātes

6. Iekārtas prototipa salikšana un laboratorijas testēšana (14.-20. mēneši)

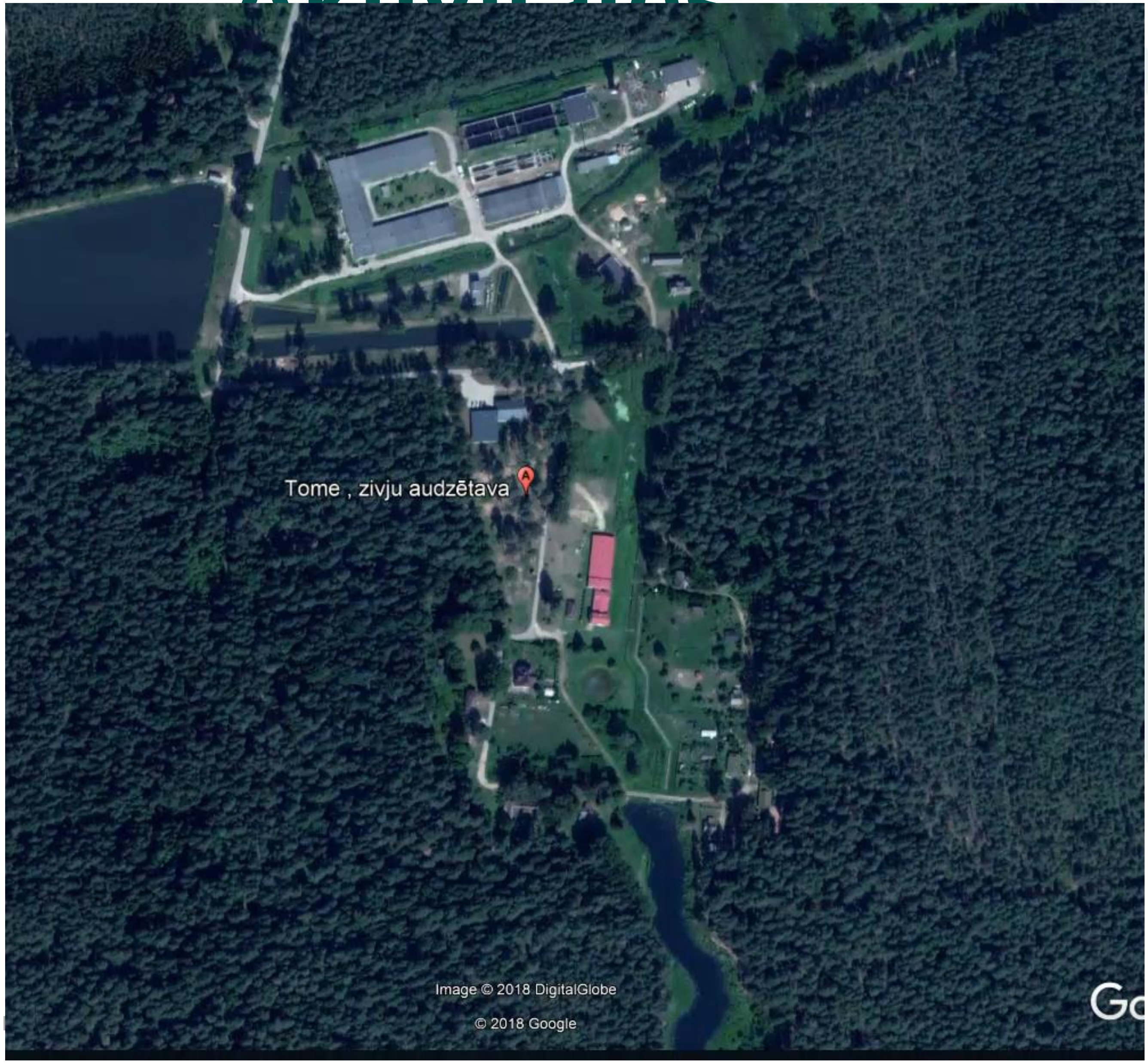
Inovācija

Projekta izstrādājamai iekārtai piemīt sekojošās priekšrocības, salīdzinot ar analogiem:

- Zemākas potenciālā gala produkta izmaksas vietējiem zvejniekiem, jo izstrāde tiks realizēta RTU ietvaros.

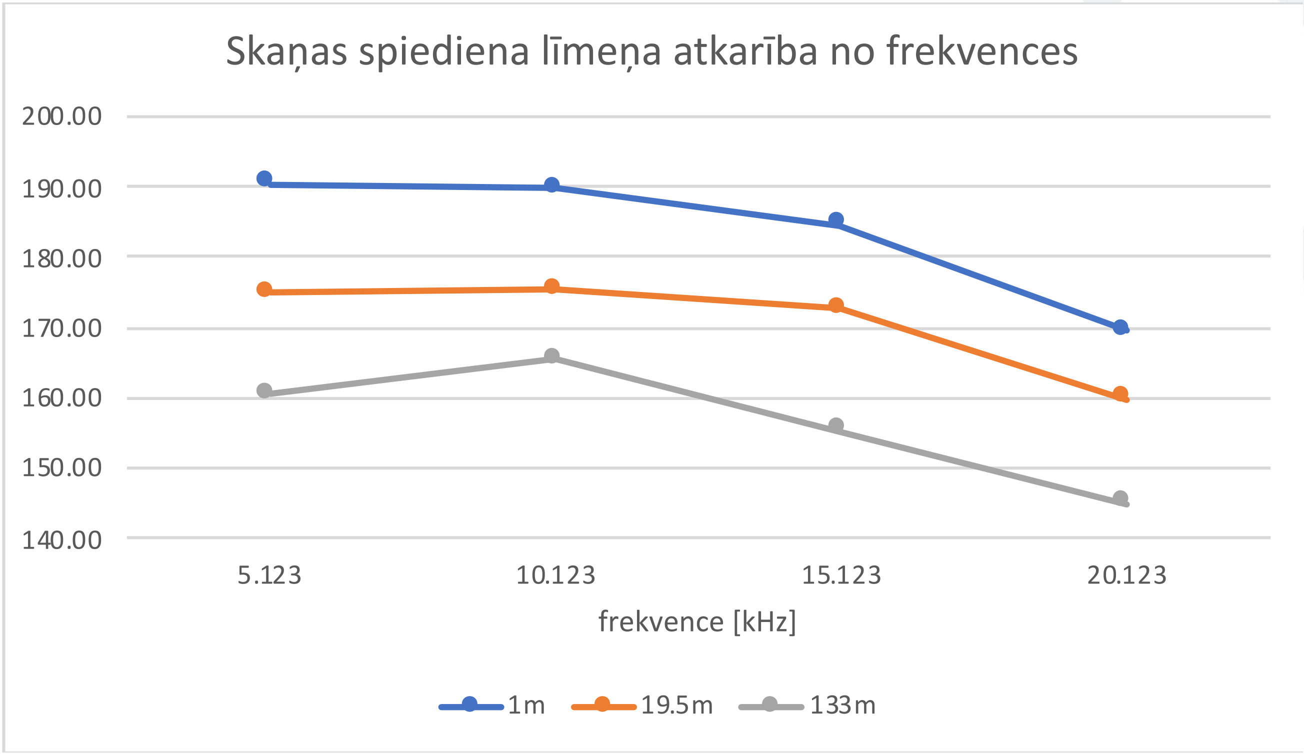
Aktivitātes

Signālu



Aktivitātes

Signālu izplatīšanas testēšana Ķīpsalā - Aprīlis 2018.



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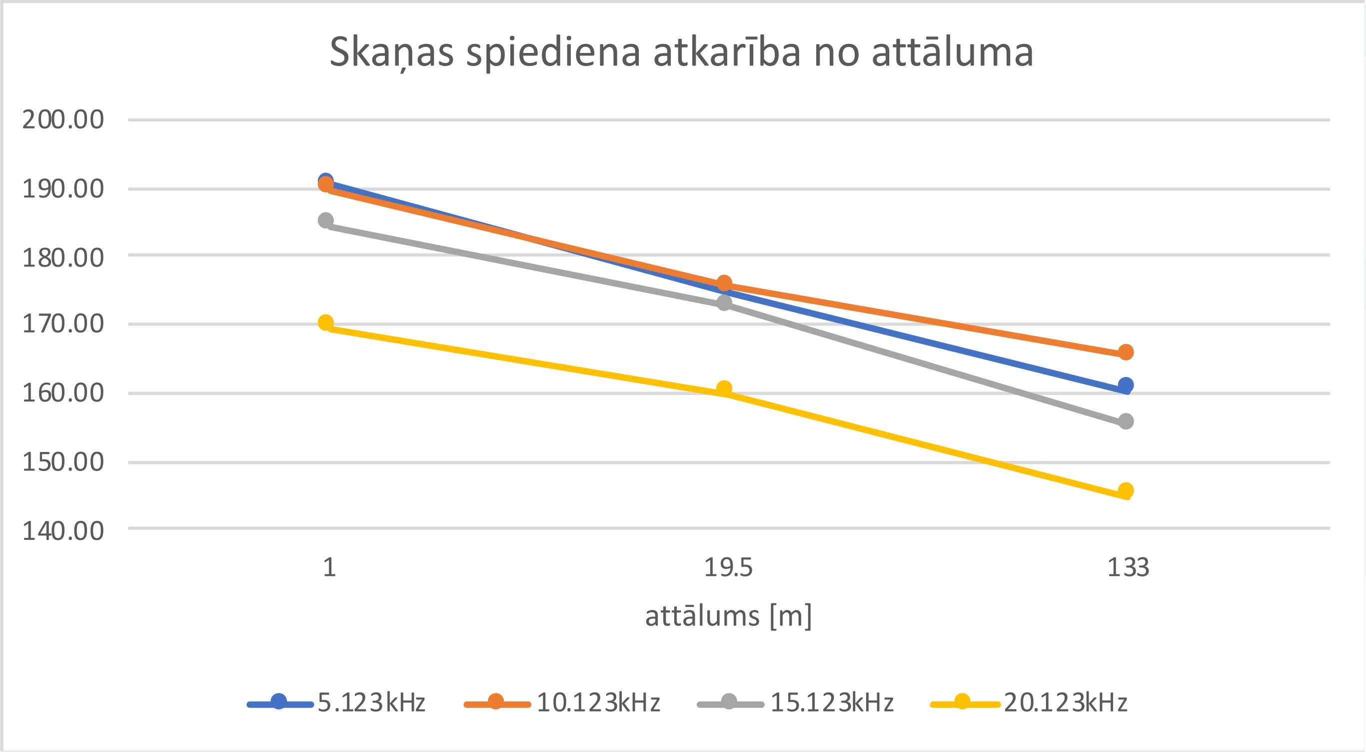
Signālu izplatīšanas testēšana Ķīpsalā - Aprīlis 2018..



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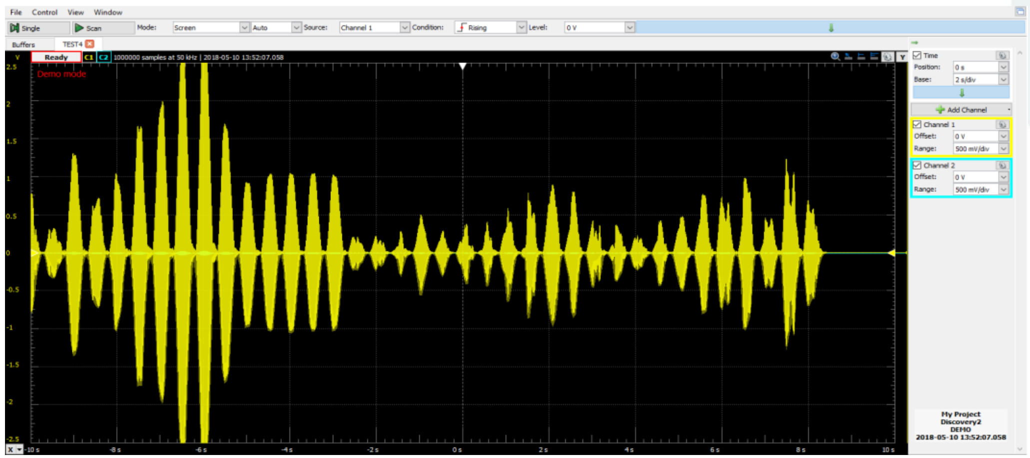
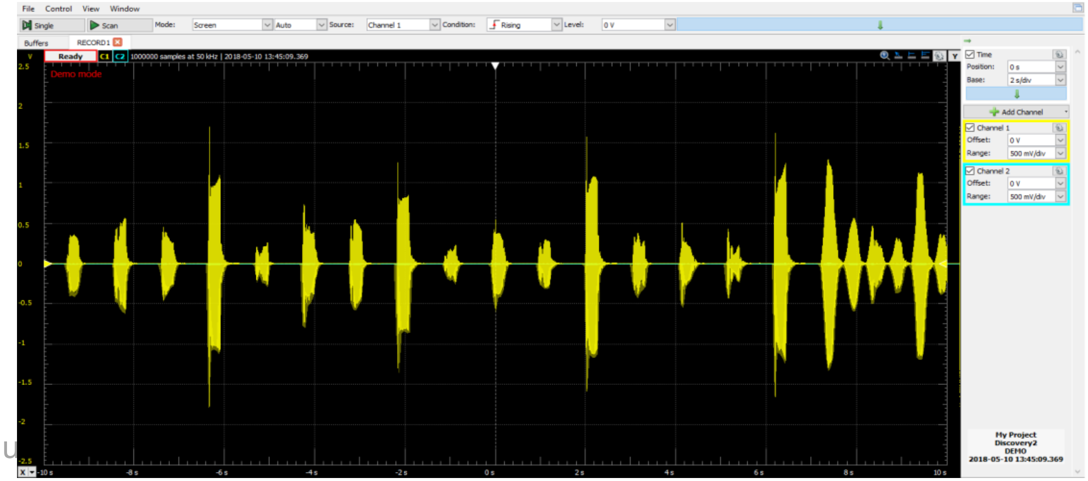
Signālu izplatīšanas testēšana Ķīpsalā - Aprīlis 2018.





Aktivitātes

Korpusa testēšana Ķīpsalā - Maijs 2018.

Aktivitātes

Iekārtas testēšanas reālos apstākļos Saulkrasti (Edgars Zviedris) 17.05.2018

Aktivitātes

Iekārtas testēšanas reālos apstākļos

Saulkrasti (Edgars Zviedris) 17.05.2018

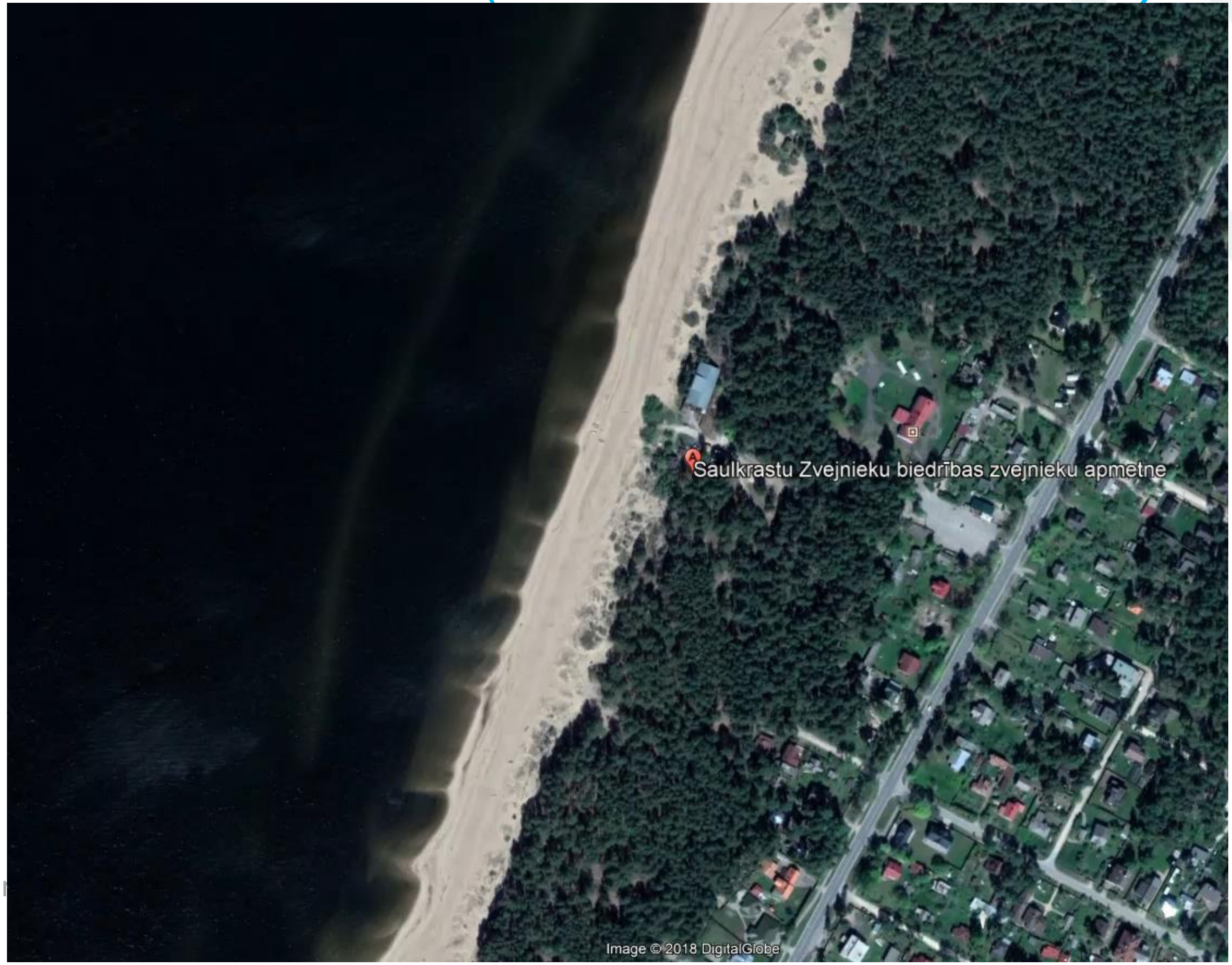
Aktivitātes

Iekārtas testēšanas reālos apstākļos

Saulkrasti (Edgars Zviedris) 17.05.2018

Aktivitātes

Iekārtas testēšanas reālos apstākļos 2018. gada jūnijs-novembris, Carnikava («Jomas» Aldonis Lukīns)



Aktivitātes

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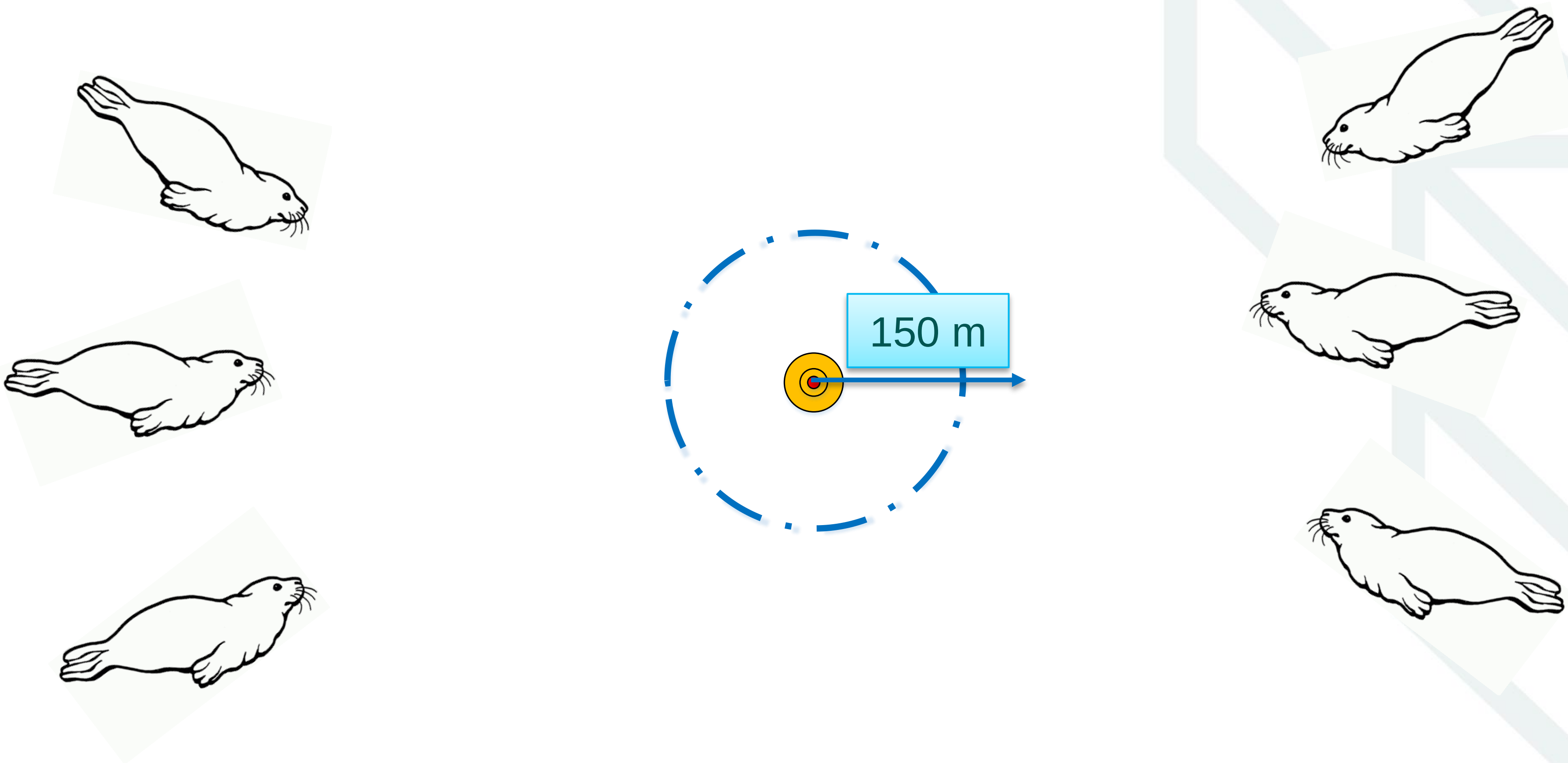

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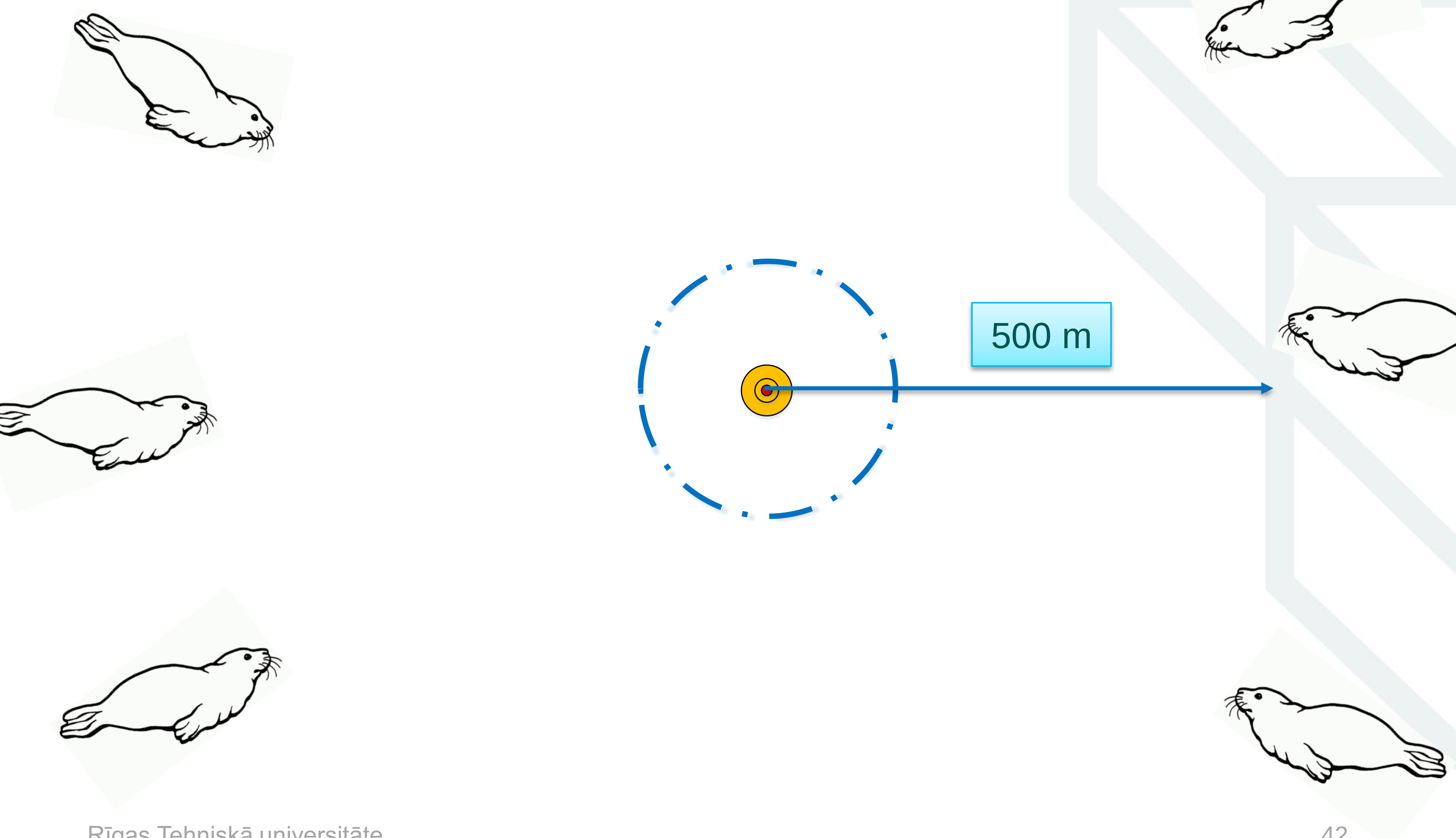

Rezultāti

Novērojumi testēšanas laikā:

- Pie ieslēgtās iekārtas murdos nebija atrasts neviens ronis;
- Ieslēdzot iekārtu roņi turas ap 500 attālumā;
- Izslēdzot- nāk atpakaļ.

Rezultāts

- Izstrādāts un reālos apstākļos notestēts paplašinātās funkcionalitātes lieljaudas zemūdens akustiskā raidītāja prototips, kas izmantojams roņu nodarīto postījumu samazināšanai Latvijas piekrastes zvejā.

Rezultātu turpmākā izmantošana praksē:

- RTU meklēs (vai radīs spin-off) uzņēmumu izstrādāta ZAR ražošanai un pārdošanai;
- Izstrādātāja tiesības tiks aizsargātas ar licences līgumu;
- ZAR prototips tiks pielietots arī pētnieciskā darbā.

Uzlabojumi

- Elektroniskas daļas vienkāršošana;
- Lietotāja interfeisa pilnveidošana;
- Jaunā tipa zemūdens raidītāja testēšana un pielāgošana:
  - Lētāks;
  - Jaudīgāks;
  - Izturīgāks.
- Sistēma ar maināmu akumulatoru- jauns konstruktīvs risinājums.

- Testēšanas turpinājums 2019.gadā.

Paldies!