



# Licensing opportunity

## Detecting current state of the congestive heart failure from heart sounds

### Field of use

Cognitive aid  
Other leisure and recreational products and services  
Health and beauty aids  
Computer-aided diagnosis and therapy

### Technology areas

Artificial Intelligence (AI)  
Computer Software  
Applications for Health

### Stage of development

Field tested/evaluated

### IPR status

Secret Know-how

### Developed by

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### Summary

The Slovenian public research organization has developed a method for detecting the current state of the congestive heart failure (CHF) from heart sounds using a digital stethoscope. Patients have periods when feeling well and periods, where they notice weakness, heavy breathing, which often requires hospital treatment. The system provides early detection of CHF worsening. The industrial partners are sought for licensing, technical cooperation or academia for research cooperation agreements.

### Description of the Invention

The Slovenian public research organization has developed a method for detecting the current state of the congestive heart failure (CHF) from phonocardiogram (PCG) using a digital stethoscope.

Congestive heart failure (CHF) is a chronic progressive condition where the heart is unable to pump enough blood to meet the body's needs. Typically, in the clinical progress there are periods of compensated phase (the patient feels well) and decompensated phase, where patients notice significant weakness, heavy breathing, and swelling in limbs and/or abdomen. Often, such deterioration requires hospital treatment with intravenous medications for successful recompensation. Early CHF worsening detection allows a physician to spare the patient from hospitalization.

The method combines classic machine-learning (ML) and end-to-end deep-learning (DL). The classical ML learns from a large body of expert-defined features and the DL learns both from the time-domain (i.e., the raw PCG signal) representation of the signal and the spectral representation of the signal. The method was evaluated on a dataset created at the local hospital and additionally on six publicly available PhysioNet datasets. There were 15 features identified that have different distributions depending on the CHF phase (compensated or decompensated). By using just two of these features, a simple and transparent decision tree classifier capable of distinguishing between the recompensated and the decompensated phases with an accuracy of 93.2%, calculated using a Leave-One-Subject-Out (LOSO) evaluation was built.

This is an entirely novel system, worldwide, to detect worsening of CHF. Although a trained physician can detect worsening using a stethoscope, the proposed method can be applied to a wearable device or a mobile phone. The computer algorithm developed allows the patient to monitor their health without (too) frequent visits at the doctor.

Additional originality comes from an innovative combination of knowledge from the fields of physics, medicine, electronics, and computer science.

The researchers are experts in the computational theory of intelligence. They have developed several practical applications in the field of

intelligent information systems, intelligent web retrieval, medicine, language technologies and others. The group has over 20 years of experience in R&D, natural language processing, and cognitive sciences

The partners are sought for among e-Health and electronic (mobile phones) industry as well as academia for licencing agreements to the secret know-how, technical cooperation agreements for joint development of the mobile phone or wearable application and research cooperation for further research in this field.

### **Main Advantages**

The main advantages of the proposed solution:

- Improved CHF treatment.
- Fewer CHF episodes and therefore fewer hospitalizations.
- The approach can be applied using only a standard intelligent mobile phone.

Currently, no adequate, patient-friendly and non-invasive technology would allow monitoring of CHF patients.

### **Partner Sought**

The partners are sought for among e-Health and electronic (mobile phones) industry as well as academia for:

Licencing agreements to the secret know-how.

Technical cooperation agreements for joint development of the system.

Research cooperation for further research in this pioneering field of telemedicine.