



## **International Contest of Innovation 2021**

**iCAN 2021**

**Final Program**

**Dec 19. 2021**

**Online broadcast**



**<https://wx.vzan.com/live/tvchat-926404290?v=1639822628605#/>**

# Schedule

**15:00/Beijing Time, Dec 19<sup>th</sup>, 2021**

<b>15:00-15:10 Opening Ceremony and Welcome Message</b>		
<b>15:10-19:10 Final Defense</b>		
<b>15mins/each including 12mins presentation and 3mins Q&amp;A</b>		
<b>Number</b>	<b>Project Name</b>	<b>University</b>
1	Real-time visualization of density change of Air by a simple camera	National University of Defense Technology, China
2	Fullness Checker	Tohoku Denshi professional School, Tohoku University, N High School, Japan
3	Development of Products Falling Prevention System in Stores Based On Earthquake Early Warnings Notices	Teikyo University, Japan
4	Huai Ning Kang-Lead Huaixiang Medicine to Become Rich and Well-off	Shanxi Medical University, China
5	The Heart of Hongmeng - Integratable Energy Harvesting Patch	Northwestern Polytechnical University, China
6	Sitting Time Counter	Tohoku Institute of Technology, Japan
7	i-Hair	Chengdu University of TCM, China
8	Fluorescence based rapid E. coli Detector	King Mongkut's Institution of Technology Ladkrabang, Thailand
9	Spot	Karlsruhe Institut of Technology, Germany
10	Middle ear infection detection system for children by a mobile phone based on deep learning technology	King Mongkut's Institution of Technology Ladkrabang, Thailand
11	Smartcase	Saarland University, Germany
12	Non-invasive glucose monitoring based on near-infrared spectroscopy	King Mongkut's Institution of Technology Ladkrabang, Thailand
13	Pre-symptomatic Detection of COVID-19 System Based on Deep Learning Technology from Smartwatch Data	King Mongkut's Institution of Technology Ladkrabang, Thailand
14	Yuhuo Technology — Fully Autonomous Underwater Robots Service Platform	National University of Defense Technology, Dalian Maritime University, China
15	Mold Prevention and Alerting	Fhnw University f Applied Sciences North Western Switzerland
16	Road Surface Condition Detection System	Ishinomaki Senshu University, Japan
<b>19:10-19:30 Break</b>		
<b>19:30-20:00 Award Ceremony</b>		

## No. 1

# Real-time visualization of density change of Air by a simple camera

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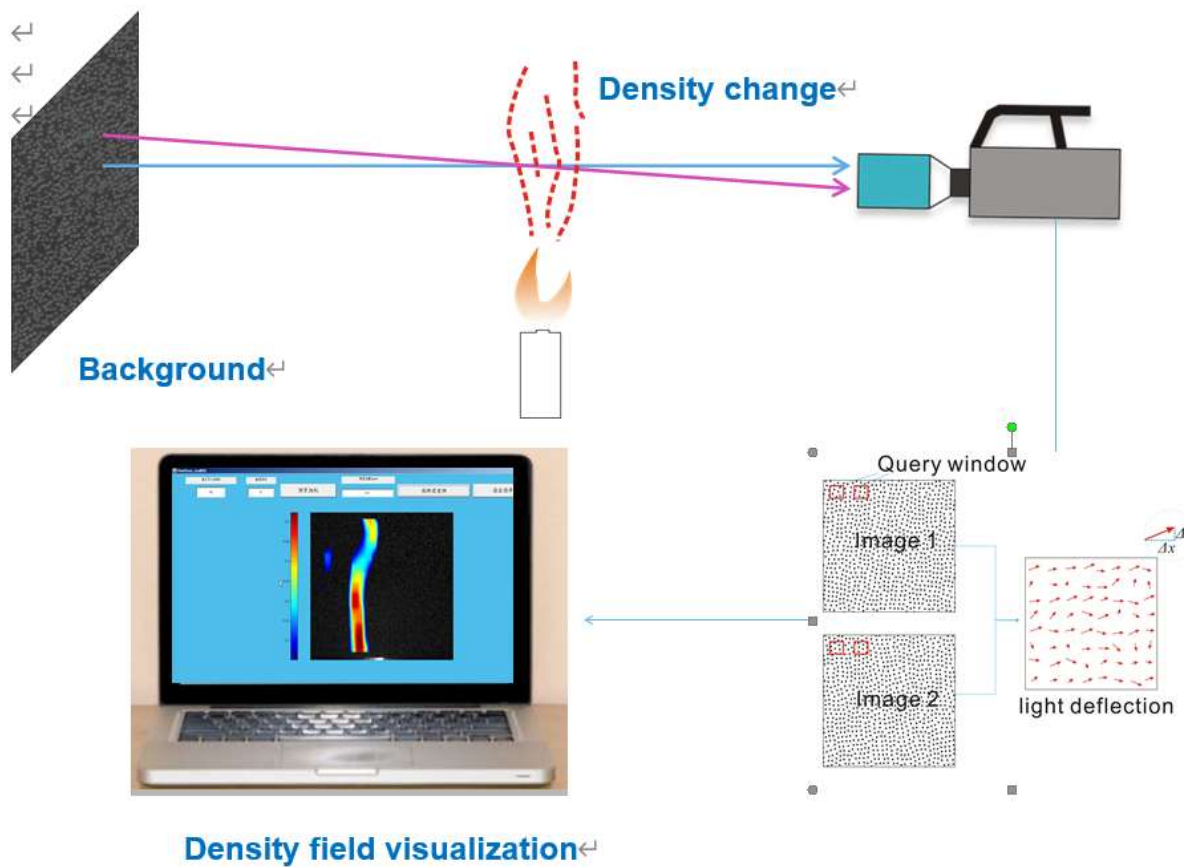
## ABSTRACT

This project developed a product that can measure the density change of Air by a single camera! Usually, the air density will change when it is heated, compressed, or mixed with other species of gas. The air density variation will influence the light transmission.

When gas runs into Air, the density of Air will be changed, as well. A traditional method is not capable to figure out how the gas leaking is happening. It is hard for a radar to find a stealth aircraft. But, when the aircraft is flying in Air, it will compress a large area of Air. So, if we can obtain the density change of such a large area then we might be able to detect the stealth aircraft.

The system of “Real-time visualization of density change of Air by a simple camera” is composed of a background pattern, a camera, and a computer. The system calculates the air density field by capturing light deflection information. When the light emitted by the background pattern passes through the disturbed air density field, it shifts on the imaging plane. We propose an improved cross-correlation algorithm to obtain the sub-pixel level light offset vector, use the geometric relationship of the optical path to calculate the refractive index distribution, and obtain the density distribution through the conversion of the GD relationship.

By monitoring the density variation of Air, the system can be used to detect forest fires, pipeline gas leaks, flight trails of stealth aircraft, and control respiratory transmission.



Xinhai Zhao



Qi Mi



Yao Xu



Bo Zhang



Wenpeng Zheng

## No.2

# Fullness Checker

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### ABSTRACT

Today, people can eat as much food as they want. Human feels full by the rise of blood sugar along with the digestion. Digestion takes a little time, so there is space between the start of eating and the beginning to feel full. The continuing of eating during this time lag causes overeating. The fast eating also contributes to the overeating. The overeating leads to cancer and heart disease, which are the disease killing the most people in the world.

In order to solve these problems, we developed a device which restricts eating and restrains you from fast eating. When you put on a belt on which the device is, the device estimates the amount of food eaten in real time based on the pressure between the belt and the abdomen, and provides feedback to the user via vibration and app notifications to reduce food intake at the eighth meal. In order to detect fast eating, which is said to be a bad eating habit, we also conducted an experiment to measure pressure when eating at a normal pace and when eating at double the pace and double the speed. The results showed that the abdominal pressure increased slowly according to the amount of food eaten in both cases at first, but then increased rapidly when the speed of eating was doubled, making it possible to detect fast eating by capturing this rapid change in pressure.

Using this result, we have implemented a mechanism that when a fast meal is detected, the device vibrates slowly to calm the user down and inhibit fast eating.



## No. 3

# Development of Products Falling Prevention System in Stores Based on Earthquake Early Warnings Notices

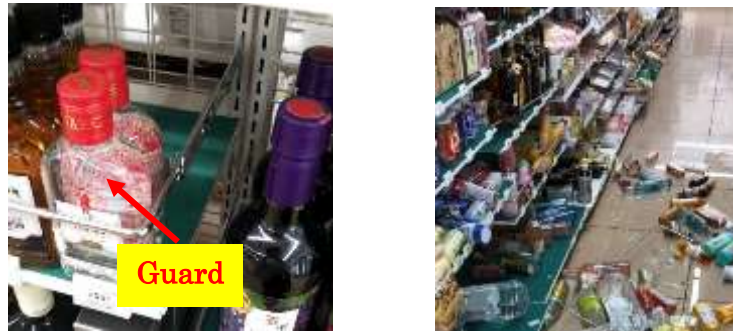
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## ABSTRACT

Japan has been hit by massive earthquakes such as the Great East Japan Earthquake and the Kumamoto Earthquake. As an example of earthquake countermeasures, a system that stops the bullet train as soon as it detects an earthquake has been developed, but earthquake countermeasures for convenience stores and supermarkets, which are sometimes closed due to falling or scattered merchandise caused by earthquakes, are not as advanced as those for transportation. Guards have been installed on the shelves of convenience stores and supermarkets to prevent damage to liquor bottles on display shelves, but these guards are ineffective in preventing product damage in a large-scale earthquake. (See Fig.1)



(a) Before earthquake

(b) After an earthquake occurred

Fig. 1 Shelf guards in convenience store

Convenience stores and supermarkets are important bases for supplying daily necessities in the event of a disaster, hence it is required to resume operations as soon as possible. Therefore, we have developed a system that prevents products such as bottles from falling or being damaged from the shelves which will enable the store to be reopened quickly after an earthquake. In order to prevent bins on the shelves of convenience stores and supermarkets from being damaged by shaking and falling during an earthquake, it is necessary to enclose the shelves and prevent bins from violently colliding with each other. Therefore, as shown in Fig. 2, a product protection frame is automatically lowered to prevent the products at the very front of the shelf from falling during an earthquake. Also, by stretching a net over the frame, collisions between bins are reduced. Furthermore, before the frame is lowered, LED tape is lit to visually warn customers not to get their hands caught.





Fig. 2 The developed system

Our system has two types of earthquake detection. One is an earthquake early warning detection system and the other is a seismic sensor using MEMS device to deal with direct earthquakes. When an earthquake is detected, a signal is immediately sent to the microcontroller, which drives the servo motor to lower the product protection frame to prevent the product from falling. The descent is achieved by attaching a servo hand to the output shaft of the servo motor and suspending the product protection frame. (See Fig. 3)



Fig. 3 System Summary

For the control of these systems, we designed and developed a control base for drop control of the frames that protect the products and for earthquake detection. (See Fig.4) To receive the earthquake early warning, an earthquake early warning detection IC (EEWWS-28), FM radio module, amplifier module, and operational amplifier are mounted. By connecting a coaxial cable or a telescopic antenna to the antenna terminal, the system receives radio signals from the nearest FM radio broadcasting station and monitors whether an earthquake early warning is being sent out. The seismic sensor can be connected using the sensor input port or mounted directly on the control board, and is programmed to detect an earthquake when the seismic intensity is 5 or higher by calculating the SI value from the acceleration. These devices are connected to a microcontroller (Atmel ATmega328P) mounted on the board, which is capable of controlling external devices such as servo motors and LED tapes via general-purpose control terminals when an earthquake occurs or when an earthquake early

warning is received. The operating power supply voltage of the control unit is 5 V, which is supplied using an AC adapter. If there is no emergency power supply in the facility where this system is used, it can be operated even in the event of a power failure during an earthquake by connecting a mobile battery.

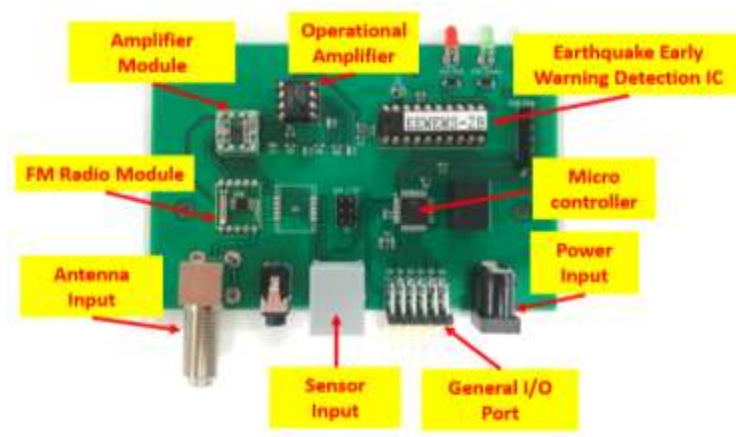


Fig. 4 The developed PCB board

In order to verify the effectiveness of the system we have developed, with the cooperation of FUJI LATEX Co., Ltd., we conducted a verification experiment by reproducing an earthquake using an earthquake generator in order to confirm the effectiveness of the system in preventing products from falling and reducing collisions between products using nets. In the experiment, assuming the detection of an earthquake by a seismic sensor, 15 bottles of 750ml (approx. 1kg per bottle) were placed on a rack imitating a store shelf, and Koube wave of the Great Hanshin earthquake, Miyagi wave of the 2011 earthquake off the Pacific coast of Tohoku, and Koube wave of the Great Hanshin earthquake were used as seismic waves to confirm the fall prevention effect of the system. As a result of the experiment, it was confirmed that the product was protected by lowering the protection frame by detecting the shaking with the seismic sensor in each seismic wave.



Fig. 4 Verification experiment using an earthquake generator

Finally, we hope that the system we have developed will reduce the damage caused by earthquakes at convenience stores and supermarkets and provide the necessary supplies to as many people as possible as soon as possible.



# Huai Ning Kang-Lead Huaixiang Medicine to Become Rich

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## ABSTRACT

Fenxi county, an old revolutionary base area, is a typical loess plateau gully area with barren land and difficult to grow cash crops. We and the local joint selection of drought - resistant double season locust new varieties introduced fenxi for large-scale planting. Improved the local environment, and now sophora rice has realized mass production and started to earn profits, and successfully achieved poverty alleviation in February 2019. How to get rich and rectify the local environment has become the most important issue at present. For many years, our team has been dedicated to the study of the constituents of *Sophora japonica*. We found that *sophora japonica* is rich in flavonoids and has excellent prevention and treatment effect of virus infection. But the absorption rate of macromolecule flavonoids is low and it is difficult to achieve the prevention effect. After a lot of research and transformation, we developed an antiviral oral liquid that can prevent respiratory virus infection of *Sophora japonica*. The product takes Shanxi medicinal tea *sophora* rice as raw material, adopts the new biological fermentation technology, compared with the traditional boiling process, enriches the effective components, and transforms the flavonoids and other macromolecules into small molecules that can be easily absorbed. Kaempferol, isorhamnetin and sitosterol assisted isoquercetin to enhance the efficacy, and the inhibition rate of virus was up to 99.1%, with very low side effects. We solved the difficult problems of obtaining small molecules such as isoquercetin, poor water solubility and low oral availability. Compared with the traditional method, the net absorption rate of human body is increased by 30 times without breaking through the cell membrane. We use molecular docking technology to verify, the results show that huaimi oral liquid prevention efficiency is as high as 11.9%, really achieve external resistance to virus, internal improve immunity, bring new benefits for fenxi farmers. In the early stage, through the mode of agricultural partnership, the company combines farmers and target customers to form a complete industrial chain, and provides employment opportunities for farmers. Downstream, terminal sales are connected, and customer resources are accumulated through various promotion channels to increase market influence. After the successful marketing of drugs in the later stage, the drug market will be comprehensively opened up and consumer groups will be absorbed. Through the sales of *sophora* rice products, the company has helped more than 5,000 poor households, served more than 120 agricultural operators, provided more than 2,000 jobs, and realized an average income increase of 19,600 yuan.

# The Heart of Hongmeng - Integratable Energy Harvesting Patch

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## ABSTRACT

The Heart of Hongmeng - Integratable energy harvesting patch

A modular energy harvesting device, which can collect large amounts of widely distributed and small densities of natural energy, has been developed by our team to alleviate the increasingly tight energy situation and to provide a green energy base for the advent of the Internet of Things.

In terms of principle, the energy generated by small disturbances can be collected by friction nanogenerators, based on the extended Maxwell's equations; the collection of dissipative heat is based on the pyroelectric effect; the collection of solar energy is done by photovoltaic power generation; the collection of raindrop energy is based on the original theory and a new collection technology is developed independently.

In terms of innovation, unlike traditional power generation devices with a single power generation mode, the natural energy harvesting patch can freely couple multiple power generation modes according to different working environments, increasing the energy output power and achieving more efficient energy utilization. During the research and development process, we developed various processes such as electret corona polarization, flexible microelectronic processing and charge preservation for low energy density, interconnection between modules and product packaging. After testing, the integrated natural energy harvesting patch has both ampere-level stable current output and open-circuit voltage output of hundreds of volts, which can meet the energy supply needs of most micro sensors.

In terms of application, the team further proposed the concept of energy toolbox to enhance the productiveness and practicality of the work, which can be widely used in different contexts such as IoT wireless nodes and extreme environment energy harvesting after promotion. The energy harvesting device can also be integrated with specific objects, such as raindrop-powered umbrellas, ocean wave energy harvesting devices, aircraft power generation skin, etc.

The Heart of Hongmeng is committed to complementing the current traditional chemical batteries and electromagnetic power generation to meet the needs of the times, and can be put into use to significantly reduce the energy burden of IOT nodes and reduce the pollution caused by disposable batteries. The team is facing the future of IOT and Metaverse, following the trend of the times, and at the same time is contributing its power to achieve carbon neutrality.

The team is facing the future of IOT and Metaverse, contributing its power to achieve carbon neutrality.

## No.6

# Sitting Time Counter

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### ABSTRACT

In the article "Evolved to Exercise (SCIENTIFIC AMERICAN January 2019)" written by Herman Pontzer, it is stated that

- Our closest living relatives, the great apes, have habitually low levels of physical activity yet suffer no ill health effects from being lazy. Humans have evolved to require far higher levels of exercise to be healthy.
- New research reveals that as human anatomy and behavior shifted over the past two million years, so, too, did physiology.
- Our physiology adapted to the intensive physical activity that hunting and gathering requires.

This is certainly true.

Human history dates back about 7 million years, and between 2 million and 10 thousand years ago, we lived by hunting and gathering. This was followed by the agricultural revolution, but humans were still very active. But after the industrial revolution, when life became more convenient, people began to exercise less and less. Our anatomy and physiology have not yet adapted to this, and it makes sense that we cannot stay healthy without exercise.

However, it is physically unrealistic, especially in terms of time, for modern people to engage in the kind of vigorous physical activity that hunter-gatherers do every day. The article by Pontzer also states that "it is not so much the quantity of exercise as the intensity of it that matters" and that "we can get the same benefits as hunter-gatherers simply by standing and working or playing".

This led us to believe that even if we don't live like hunter-gatherers, we can avoid the health problems caused by inactivity if we continue to exercise at the "standing" level more often and spend less time sitting. As evidence to support this, today, the World Health Organization ranks physical inactivity -sitting too much- as the fourth biggest preventable killer globally, causing an estimated 3.2 million deaths annually. The book "Deskbound: Standing Up to a Sitting World", by Kelly Starrett et al, also states that "Human beings deteriorate their health by sitting."

Taken together, this suggests that we are in a situation where our health is being compromised by prolonged sitting and that we need to do something about it. However, it is difficult to do this on one's initiative, because managing one's own sitting time is an extra task for work and study.

With this in mind, our team has created an application that makes it easy to correct the health problems caused by prolonged sitting.

#### [Application features]

The application's function is to automatically measure the duration of a person's sitting time, determine whether the person is sitting too much, and provide real-time feedback on the results via a smartphone. With this function, it is possible to correct the habit of sitting in the modern world and to correct the health problems caused by excessive sitting.

The criteria for determining over-sitting is based on the book "Deskbound: Standing Up to a Sitting World" by Kelly Starrett et al, which states that "For every 30 minutes that you are deskbound, move for at least 2 minutes".

#### [Production Method]

We used an accelerometer called "MPU6886" made by MEMS technology to determine the human posture. Other devices such as the "M5StickC Plus" and the "Blynk" IoT platform were used to implement the application. The method of communication between the application and the smartphone is "Wi-Fi" or "Bluetooth".

#### [Results]

The device allows us to visualize data on sitting and standing positions and notifies us on our smartphones if we sit for more than 30 minutes, which means that we rarely sit for long periods.



## No.7

### i-Hair

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#### ABSTRACT

According to the National Health Commission, there are about 250 million people with alopecia in China, with an average of 1 in 6 individuals. Alopecia has been an urgent problem in contemporary health and shows a trend of rejuvenation, and our germinal and developmental hair market is about 334.2 billion. Existing germinal products have disadvantages such as low cost for money, little benefit, easy recurrence and long course of treatment. Therefore, there is an urgent need in the market for an affordable and efficient smart hair product [project overview] to scientifically address seborrheic alopecia, telogen alopecia, and alopecia areata by combining smart hair bearing machines with Tibetan medicine agents to break down the traditional hair regimen. The instrument internally piggyback on an autonomous R & D graphene electrothermal membrane to promote head lymph metabolism to provide energy for germinal production; Also paired with Tibetan medicine light walnut kernel oil, increased  $\beta$ -Catenin protein expression, which provides nutrition to the germinal tract; And synergistic fixation of hair combined with traditional Chinese medicine Qi Yi method prescription. The clinical overall response rate was 98.6% as determined by a study of tri methyl hospitals including West China Hospital of Sichuan University and Sichuan Provincial Hospital of traditional Chinese medicine. Innovativeness using TCM body identification and acupoint sensitization technology applied to the i-hair germinal management system to achieve smart diagnosis and compensate for the gap in the smart germinal market, and is certified by the international SGS, FDA, the company was established this year after receiving seed wheel financing, immediately submitting cosmeceutical features and class II medical devices and CFDA applications for filing, and is expected to be approved by the end of the year through the green channel ( ① Technological innovation: innovation use of light walnut kernel oil to regulate lymphatic stem cells cooperate with graphene infrared induced acupoint effect technology to germinate and guarantee the supply of energy source and nutrition for hair growth, new report from review of science and technology indicates: technology is the first for the world and reaches the leading level internationally ② program innovation: to prevent hair recurrence, In this product, combined with traditional Chinese medicine Qi stimulation and tens transcutaneous pulsed electrical stimulation of hair fixation, better inhibits the synthesis and release of HPA axis related stress molecules, decreases damage to hair follicles, improves the stress state at the site of skin injury, tonizes the liver and kidney, calms blood deficiency drying, performs Qi while passing blood stasis, With solid hair for growth ③ functional innovation: This product breaks down the monopoly status of low-energy laser germinators with only single therapeutic function on the market, and innovatively applies acupoint sensitization technology with TCM body

identification based on exclusive germinal technology to analyze the situation of hair follicles in real time, providing an intelligent personalized hair scheme. Bringing more targeted intelligent diagnosis and treatment services to patients ---- project progress ① in depth hair research for 6 years, animal experiments have been completed and pre clinical trials with 1326 volunteers ② 23 patents have been applied / obtained both in China and abroad, the products have completed the transformation of technical results, clusterin I development and marketing operation, industrial design of clusterin II products, Being engaged in industrial batch production with Shenzhen Shuo company and its partner plants, it is expected to be marketed early next year; ③ Have entered into cooperative agreements and orders with several hospitals and enterprises, and have partnered with pecan plantations in Derong County, which covers 100 mu of cultivation area and brought 6 farmers to realize significantly increased returns in 2019, 2021 the team received the seed wheel financing from Huayan holding group two million and founded the company in June ④ the pecan kernel pre oil stage as an in-hospital preparation was financed 540000 in two months ⑤ the company nurtures multiple innovative professional talents to promote research and development in this field, leading to more than 20 employment.





## No.8

### Fluorescence based rapid E. coli Detector

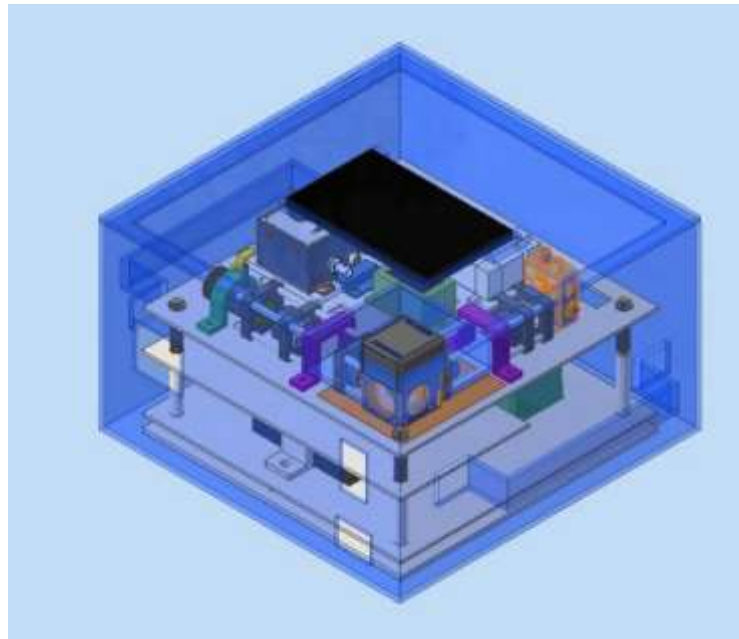
King Mongkut's Institution of Technology Ladkrabang, Thailand

Thitiyo Chantharasuriyasakun, Siriyakorn Sungwol, Nicholas Piyawattanametha

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#### ABSTRACT

Water is one of the most significant problems for almost every country around the world including Thailand. Thailand has faced this water management problem both quantities and qualities for decades. The World Health Organization (WHO) therefore, ought to examine the contamination in the water that impact on human consumption, which then consequently resulting in the health problems and diseases such as diarrhea and cholera. For the worst case, it can lead to mortality in case of having long-term consumption or consume in a large amount. Furthermore, contaminated water can also be a source of disease widespread as well. In order to examine the contamination of the water, enumerated in the number of E. coli is one of the World Health Organization preferred indicator. Unfortunately, the current method to qualify the E. coli enumeration needs the laboratory involved and takes time about 24-72 hours as the collected sample needs to incubate overnight. Another issue is the laboratory involved examination, in addition to having long time taken for the results, it is might not be contributive to inspect the water quality in communities far from urban or rural areas due to the inability to move the device outside the laboratory and the need of specialized training for staff performing the examination. Fluorescence, a well-known technique used in various laboratory experiments, plays a crucial role in the enzymatic analysis of the microbial in the water. As the Escherichia coli analysis can indicate the quality of the water, fluorescence detector is developed and becomes a well-established method using the enzyme-substrate reaction between  $\beta$ -D-glucuronidase (GUD), a specific marker for Escherichia coli and 4-methylumbelliferone- $\beta$ -D-glucuronide (MUG), a sensitive substrate for determining the presence of E. coli. However, the current fluorescence detectors are bench-top machines and required to do the experiment in the laboratory. The purpose of this project is to advance the technology for water management, fluorescence-based E. coli detector. This project will emphasize on the disadvantages of the current fluorescence detector and will be developed based on those weaknesses. This fluorescence-based E. coli detector will be able to give accurate alongside with rapid results within an hour. Furthermore, with a user-friendly, this detector will be easy and portable to use. After developing and testing the detector, this project can further development to publish for the related institution or institution that is interested in this project to utilize it to the fullest.



## No.9

## Spot

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Saito

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### ABSTRACT

Spot is based on a versatile, customizable lighting concept. This concept makes it possible to respond to the needs of customized lighting.

But what is new about the idea?

Many lamp manufacturers advertise adaptable lighting, particularly simple control or a particularly chic design. Spot implements all these features in one product and offers much more. In contrast to conventional lamps, Spot offers intuitive gesture control, optics for bundling and increasing light intensity, and display of freely selectable content. Spot unleashes the full potential of the workplace and/or living space through targeted lighting and interactive projections. Spot comes with three modes: Customized large area illumination, a focused beam to selectively illuminate small areas and a freely customizable mode which displays individual content, so that the illuminated surface simultaneously takes on the function of a screen. Intuitive gesture control, which allows switching between these modes completes the functionality of Spot.

Spot can take the function of a traditional ceiling lamp or desk lamp and enhance it with a focused beam and adaptive content. The possibilities for using Spot are numerous. The mode for displaying interactive or passive content creates a limitlessly expandable platform. Spot has great potential to be used as a useful productivity enhancer in the workplace, individualization of one's living space as well as an extension of limited space. The prototype developed combines extensive functions in an elegant aluminum housing. With an app, not only can the color temperature, brightness and illumination area on a worktable be individually adjusted, but customized content for work and leisure can also be projected onto a table surface. The heart of Spot is an interplay of microcomputer, camera and sensors for hand and gesture, camera and sensors for hand and gesture recognition, as well as a DMD projector with downstream optics. The high-contrast projector not only produces a reading or working light, but also makes many other applications possible. Examples include applications such as screen enhancement, computer input, party light and DIY assistant.

# **Middle ear infection detection system for children by a mobile phone based on deep learning technology**

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## **ABSTRACT**

Ear infection or otitis media is a common disease of the middle ear, which is very common in children. Most of the causes are mild influenza infections, which lead to fluid accumulation in the middle ear. If fluid or mucus is stuck in the ear, it can cause an infection in the ear, which can cause pain and can damage the ear permanently if it is left too long without treatment. As a result, it will slow down long-term development in children learning due to the inability to hear sounds correctly.

The diagnosis of an ear infection is typically performed by physically examining internal ear structures with an instrument called an otoscope. A normal and healthy eardrum has a pinkish-gray color. The healthy eardrum is clear, while an infected eardrum is bulging (swollen) and reddened. A doctor may perform tympanometry, which measures how the eardrum responds to a change of air pressure inside the ear to check eardrum integrity. However, one of the most common methods to test ear infection is to perform hearing tests, especially in children who have fluid in their ears. Currently, most assessments of middle ear fluid are costly and time-consuming. The testing processes require additional diagnosis. As a result, most children will be sent home until the symptoms get worse. Thus, there is an urgent need to develop a device for identifying abnormalities in the middle ear that does not use costly equipment or attachments, can evaluate eardrum mobility, and requires minimal expertise. This project aims to develop a smartphone-based ear infection detection with a chirp sound based on deep learning technology that can be portable, and an easy-to-operate hearing test instrument to increase accessibility in hearing the diagnosis. Therefore, an iPhone was chosen as a platform to miniaturize all required features from traditional hearing test instruments into. This smartphone uses synthesized bird chirping sound waves to detect reflections with interfering waveforms from the eardrum to compare the differences between ear with fluid and without fluid. The sound used has the frequency and volume level in the range that does not cause damage to the patient's ear. Then, all operations are executed on an iPhone operating system (iOS) application. Besides, for accuracy enhancement in the analysis of the results, deep learning technology was used in the data to provide a probable prognosis.



# No.11

## Smartcase

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### ABSTRACT

New ideas within technology are used to shape our world into a better place. With smart applications and devices we are getting support within different tasks everyday, which makes our lives more pleasant and leads us to gain more efficiency. Our contribution is the idea of a modul, which can be implemented to various moveable, motorized objects, enabling it to follow its user autonomous and smart.

As one of the possible use cases, we integrated such a module into a travel suitcase, thus creating the SmartCase. SmartCase is a suitcase extended with an electronic system, which consists of different sensors in its shell, two motors for its wheels, a camera and a microprocessor. This is allowing it to react to obstacles and possible dangers in real time and follow a dedicated user within his path. In this case, the aim is to make traveling more comfortable for passengers and making them more efficient. Furthermore, it can help people with physical disabilities to carry their baggage. When adjusted through a few changes, concerning the parts of the module, the SmartCase-module can be used to create or combine systems, which support people in their daily lives or in their work environment. The electrical engine and the controls work together to enable the system to follow its user and react to obstacles in an intelligent way.





# Non-invasive glucose monitoring based on near-infrared spectroscopy

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## ABSTRACT

For decades, the percent of a patient who got diabetes is rising every year. It means that many people have to use blood glucose monitoring. Diabetes, or diabetes mellitus, is a disease that causes a high blood glucose level where the normal blood glucose level is about 90-140mg/dl. Typically, the pancreas releases insulin to control the level of blood sugar. Insulin is the critical factor in converting the form of glucose into energy. When the insulin cannot work well, the ability to change blood sugar to energy is also inefficient, which causes a high amount of glucose in the blood. There are three main types of diabetes which are Type 1 diabetes mellitus (T1DM), Type 2 diabetes mellitus (T2DM), and gestation diabetes mellitus (GDM). Diabetes mellitus is also divided into two groups such as Hyperglycemia and Hypoglycemia. Hyperglycemia is focused on a high glucose level in the blood ( $>150$  mg/dl) which can cause a diabetic coma. On the other hand, Hypoglycemia is concerned about the blood glucose level falls below a certain level ( $< 60$  mg/dl). Furthermore, this condition can lead to a severe problem which is stroke. Therefore, the blood glucose measurement needs to be checked for diabetes patients.

In general, the blood glucose level is detected in an invasive way to measure the blood glucose level, including using finger-prick devices, fasting plasma glucose, and HbA1C. These methods give a highly accurate output value, but patients can be suffered from pains, and it can cause infection by using the needles to draw blood. Thus, we introduce non-invasive blood glucose monitoring, which can diminish the pains. This research uses the near-infrared LED in the wavelength of 940 nm and the pulse oximeter sensor which has the wavelength of 660 nm and 880 nm for finding the relationship between the absorbance voltage and concentration of glucose (50 mg/dl to 240mg/dl). As the block diagram shows, the near-infrared LED emit light to the glucose solution. Then the photodetector would receive the light absorbance from the glucose solution. The notch filter is used for reducing the signal interference. After that the voltage data of near infrared are gained. For the pulse oximeter, the pulse oximeter is emitted the red and infrared light to the glucose solution and then the data is shown in the monitor. After the data of the near-infrared and pulse oximeter are gained, the data was sent to MATLAB for the analysis. Figure 2 shows the second-order polynomial curve fitting of Near-infrared sensor in the wavelength of 940 nm.

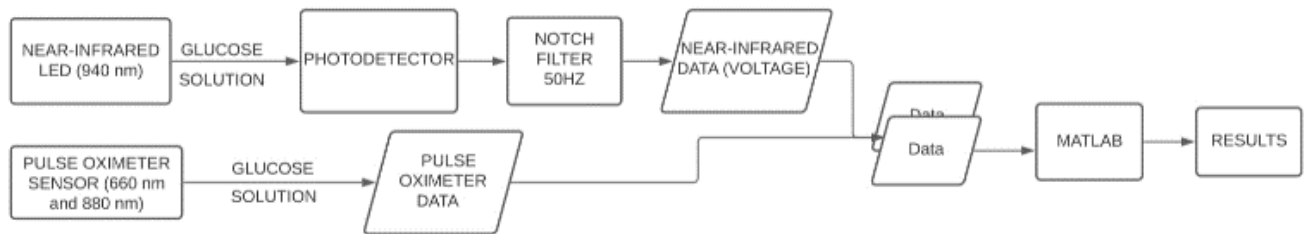


Figure 1: The block diagram illustrates the process of blood glucose monitoring based on NIR spectroscopy.

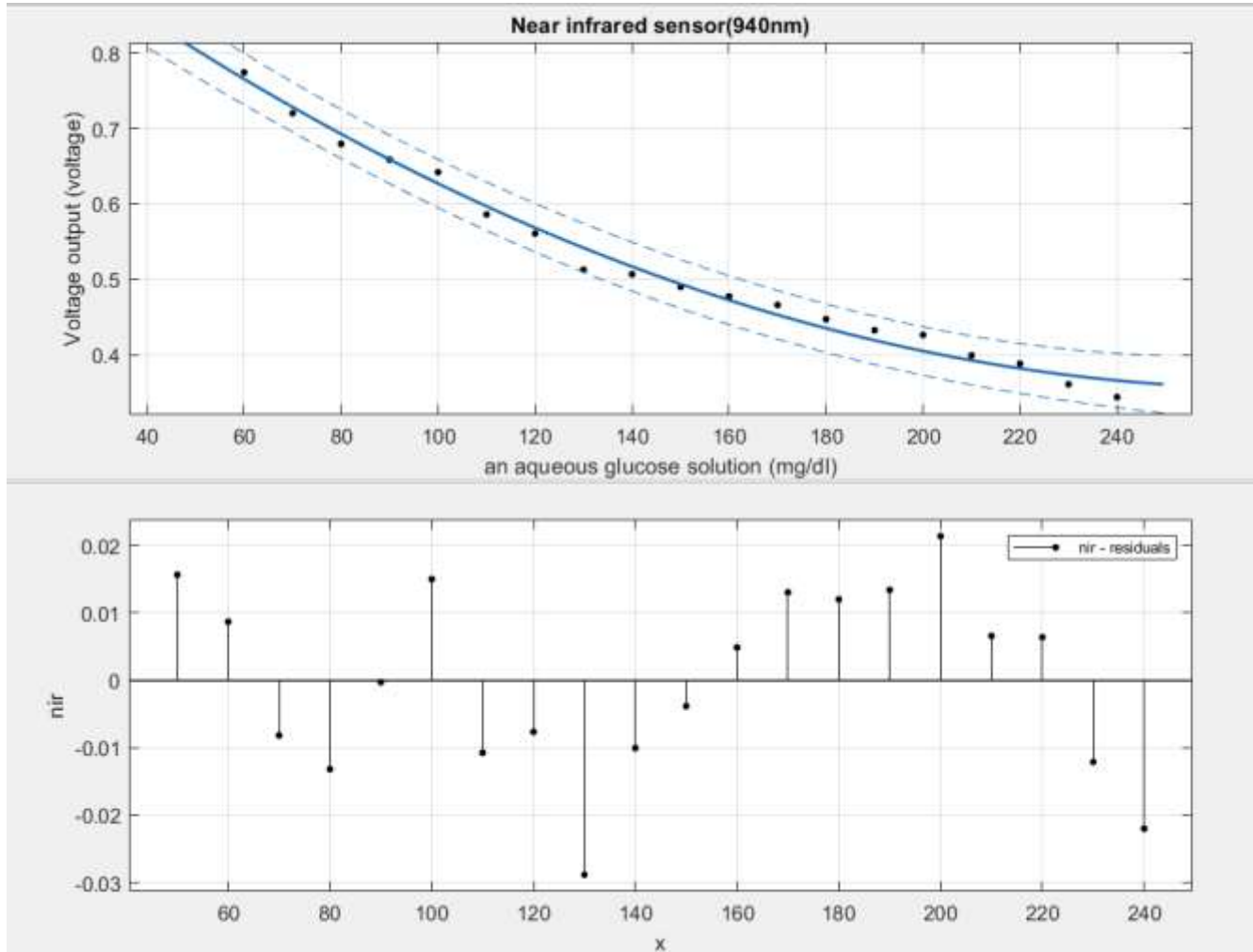


Figure 2: The second-order polynomial curve fitting of Near-infrared sensor in the wavelength of 940 nm.

# **Pre-symptomatic Detection of COVID-19 System Based on Deep Learning Technology from Smartwatch Data**

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## **ABSTRACT**

At the moment, the entire world population is battling COVID-19, a contagious disease caused by the coronavirus. The coronavirus family is the largest virus family found in both animals and humans. The coronavirus also causes a variety of illnesses. People infected with the novel coronavirus disease 2019 (COVID-19) will experience symptoms similar to those seen in patients with respiratory tract infections, with symptoms ranging from mild to severe, including nasal congestion, sore throats, cough and fever. In severe cases, they may also develop pneumonia or have difficulty breathing. Some people may die as a result of the coronavirus, but the elderly and people with underlying diseases such as diabetes and heart disease are at risk of severe illness if exposed. According to the World Health Organization, the coronavirus has now mutated. WHO Coronavirus (COVID-19) dashboard shows the number of infected people admitted to hospitals with COVID-19 is increasing, based on the current situation, resulting in a shortage of medical personnel and insufficient medical equipment to meet demand. At present, the hospitals have stored daily patient data by using a device or attaching a device to the patient's body such as attaching a node to measure the patient's ECG or attaching a biosensor used to measure the patient's temperature and send data to patient monitoring. This process requires the patient to be always bedridden or close to the medical devices causing limited mobility or discomfort for patients. Sometimes there are patients who are out of bed or going to the bathroom, which can cause information from the patients to be inaccurate or omitted. As a result, the researcher created a remote health care system to reduce the burden on physicians in monitoring individual patients and to assist in resolving the issue of an insufficient number of medical devices to meet demand and problem that occur from hospital system or from patients. Moreover, the value of health care programs for disease monitoring systems is very important. For example, the wireless body area network, the cloud computing, and the medical decision that doctors can advise patients immediately. Thus, we need the patient monitoring system that used sensors to collect information about the patients' vital sign data. The vital signs are the health metrics that are easily measured by wearable devices that can detect pre-symptomatic signs of COVID-19. Then, we develop the application to represent the vital signs from

smartwatches on smartphones or tablets by coding Java and Python. The vital signs data are stored in the database, which has the deep learning technology that is able to analyze results and alert the body's abnormalities. All patient information is sent directly to healthcare professionals. Healthcare professionals will diagnose the symptoms, find treatment for the patients, and follow up with the patients through the application or server of the healthcare professionals. This project has the purpose of developing a public health system to reduce the workload of healthcare workers is to fast-track patient vital signs and reduce the distances between COVID-19 patients and healthcare workers. Under this research project, we want to create a remote vital signs measurement system to be used as a prototype for further.



Photo1: Pre-symptomatic detection of covid-19 system based on deep learning technology from smartwatch data.

# Yuhuo Technology — Fully Autonomous Underwater Robots Service Platform

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### ABSTRACT

The fully autonomous underwater robots service platform is a deep learning-based intelligent fishing robot platform that targets sea urchins, scallops, and sea cucumbers. It uses the Ardusub open-source system, with Raspberry Pi as the master control. It is composed of the ground station, the body with the main controller, and the umbilical cable. Under this platform, the underwater robot uses image recognition technology to determine the grasping target. Then, the ground station performs carrier communication with the flight controller through the umbilical cable. Finally, the preset arm movements of robots are performed to achieve autonomous grasping under the control of the ground station.

As for the robot control problem, considering that electromagnetic waves have relatively strong attenuation underwater, we use umbilical cables to communicate with ground stations and robots. For the robot, we use the Ardusub open-source robot system, and we use QGroundControl (QGC) supported by Ardusub technology for the ground station. Carrier communication between the ground station and the flight controller that controls robots can not only realize the control of the robot's propeller, camera, and manipulator but also get the real-time video. Besides, the main controller body of the robot includes 3 pairs of positive and negative propellers, 1 flight control board, 1 power management module, 1 Raspberry Pi circuit board, 2 underwater searchlights, and 1 1080 -P camera, and a solid buoyancy block. It is worth noting that the propeller is used to control the floating and left-right movement of the robot, and the flight control board is used to sense the state of robots. Finally, the main controller body can collect sensor information through the flight controller, control thrusters, steering gears, etc., achieving control of robots.

Aiming at the design problem of the robotic arm, we made a six-degree-of-freedom robotic arm, which includes: a robotic arm frame, a metal mechanical claw, a magnetic sensing waterproof steering gear, an Arduino single-chip microcomputer, a WiFi module, and an umbilical cable. The robot arm frame is made of an aluminum alloy, which has advantages of high hardness, corrosion resistance, and easy production. The steering gear is based on the working principle of radium radiation. It has the characteristics of waterproof and large torque, which supports the robot arm to work under 20M underwater. At the same time, we use the Arduino single-chip microcomputer

to control the magnetic sensor steering gear, and finally, realize remote control of underwater operations on the shore.

In terms of image enhancement and recognition technology, due to the complexity of the underwater environment and the different laws of light propagation underwater, vision processing underwater is facing new problems. The current research mainly focuses on vision processing without changing the hardware. The image undergoes super-resolution reconstruction to obtain high-quality underwater images. We improve it on the basis of the GAN network, using the improved super-resolution generative confrontation network (SRGAN) to super-resolution the input image Refactoring. The SRGAN can pull the closely arranged pixels of the original image apart during the super-resolution of a single image, and use the GAN network to fill the intermediate pixels to achieve a high-resolution generation of realistic textures. Enhanced SRGAN, called ESRGAN, always outperforms the most advanced methods in sharpness and detail.



At present, we have conducted field tests on the underwater robot in the sea area of Zhangzi island in China. Aiming at the autonomous sea cucumber grasping task, compared with manual grasping, the robot we design presents great superiority in underwater fishing tasks. We build a mathematical model to calculate the capture efficiency in the case of robot clusters and compare it with the data of sea cucumber catchers. The results show that underwater robots can capture sea cucumbers more quickly and accurately. In addition, because the underwater robot is designed to be a propeller rather than a crawler, it has less damage to the marine environment and does not damage the original environment of the seabed; at the same time, the split structure design will not cause harm to scallops, sea cucumbers, and sea urchins. It can also allow the robot to adapt to different seabed environments.



# Mold Prevention and Alerting

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### ABSTRACT

Air quality is important for human health. Mold in buildings can pollute the air with spores and can be a danger for its residents. By the time mold is detected, health implications have often already begun. This can be especially dangerous for people who already suffer from pre-existing conditions. Furthermore, expensive renovations are often necessary to get rid of the mold.

To be able to prevent mold, there first needs to be an understanding why mold forms on a wall. Mold usually forms due to an exposure of the wall to moisture. The root cause of moisture is often a leaking roof or cracked walls. In these cases, there is not much left to do other than expensive repairs and careful monitoring. Another reason is insufficient wall insulation, therefore the inside surface of the wall becomes much colder than the adjacent room temperature. Because relative air humidity is temperature dependent, it is possible for the humidity in a room to condense on cold walls. Over time this invisible effect can rapidly accelerate mold growth. However, this can quite easily be avoided by frequently airing the room, which replaces the humid air with dry air that dehumidifies the walls. For a safe prevention of mold growth, the relative humidity on the surface of the wall should not exceed 80% on a permanent basis.

The scope of this project was to develop a product that detects if a certain room is at risk for mold formation by determining the wall humidity. The product is designed to work as an early warning system for its user and can therefore help them take actions before mold begins to form. If used correctly, it should eliminate the risk for renovations. To achieve this, the product consists of a custom designed sensor device and a web hosted software solution.

The sensor device is equipped with multiple sensors that measure environmental parameters. This includes air humidity, air temperature and wall temperature. With those parameters, the wall humidity is calculated. The sensors are mounted on a custom-made printed circuit board. Key components on the pcb other than the sensors are the battery controller, the STM32 microprocessor and the WiFi Module. Because of the usage of WiFi for the

sensor connectivity, the user can connect the sensor with his already existing home WiFi network. Therefore, no additional wireless base station is needed and thus the costs are reduced. The pcb resides in a 3d printed case, which can be easily attached to a wall with tape. The sensor is powered by a LiPo battery, which can be charged by connecting the USB-C port with a power source.

The communication between the sensor device and the web hosted software solution is based on the MQTT protocol. The received data is stored in a time series database. The stored data then gets analysed to detect if the environment is susceptible to grow mold. If this is the case, an alert is sent to the user, for example over Microsoft Teams. The alerts as well as the raw data are presented with graphical plots in an understandable and accessible way. Because the solution is web-based, it can be accessed from a variety of different devices. The visualization is realized with Grafana, an open-source visualization and observability platform. As soon as a new sensor device sends data to the web service, it is automatically shown on the dashboard.

The team consists of three electrical and information technology students who started their bachelor studies in summer 2020 and are now in their third semester at the University of Applied Sciences Northwestern Switzerland, FHNW. Daniel Richner is project lead and develops the computer software as well as electronic hardware. Joel Becker designs and implements the embedded software. Fabian Gärtner focuses on electronic and mechanical hardware development as well as application engineering.



## No.16

### Road Surface Condition Detection System

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#### ABSTRACT

To dear drivers all of the world, when you go to work early in the morning by car during the winter season, I guess everybody is worried whether the roads are frozen (iced) or not, right?

Specially in the winter season, the temperature decreases below the freezing point from night to early morning and the road often freezes. In such a dangerous frozen road condition the car may slip, increasing the risk of fatal accidents.

In order to avoid such traffic accidents, we have proposed a novel project called "road surface condition detection system" mounted on a vehicle to detect a frozen road as shown in Fig. 1.

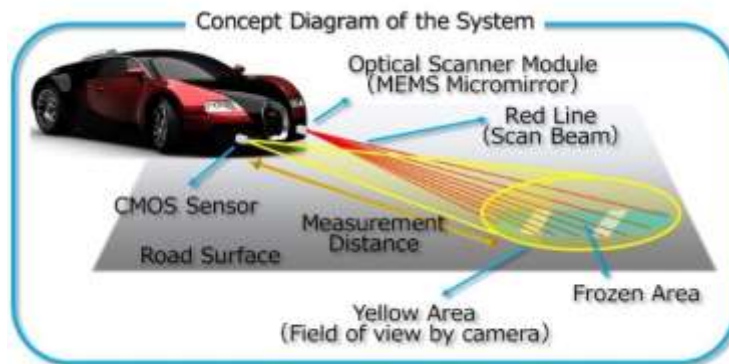


Fig.1 Frozen road detection system mounted on a vehicle using a MEMS micromirror and a laser beam. See “References” for the car picture1).

If it is known in advance that the road surface is frozen, a slip accident might be avoided by warning the driver to decelerate the car speed by a beep sound or even decreasing the speed automatically. In order to realize such a system, we designed and fabricated a system which consists mainly of a MEMS micromirror, a laser tube, a CMOS sensor, an Arduino microcontroller board combined with a Raspberry-Pi embedded computer. One of the key points of this project is to give a sufficient time (4 to 5 seconds) to decelerate manually or automatically the vehicle speed. The distance between the vehicle and the detection area is determined by this sufficient time and the current speed value.

The road condition detection control is as follows. A laser beam irradiates the road and its illumination image is taken by a CMOS sensor. This procedure is continuously performed. The captured image is analyzed by a Raspberry-Pi embedded computer to determine whether the road surface is frozen or not. The computer makes a judgment based on the brightness of light.

By using the MEMS micromirror, which is the key device of this project, it is possible to investigate the road surface condition over a wide range. In this application, a two-axis MEMS micromirror (Nippon Signal Co., ECOSCAN) has been used.

The principle of detection is as follows. A laser beam is scanned by a MEMS micromirror on a determined area of the road. The laser is diffusely reflected when the road is dried as shown in Fig. 2. On the other hand, the laser beam is specularly reflected when the road is frozen (iced) as shown in Fig. 3.

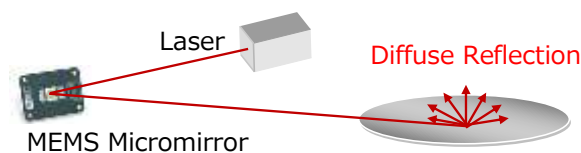


Fig. 2 Diffuse reflection of the laser beam occurs on dried road. See “References” for the MEMS micromirror picture2).

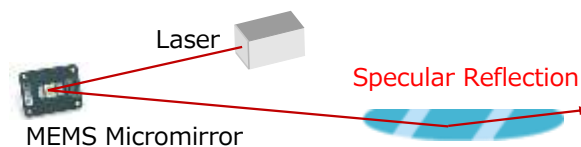


Fig. 3 Specular reflection of the laser beam occurs on frozen (iced) road. See “References” for the MEMS micromirror picture2).

Image of the laser scanned area is taken by a CMOS sensor. In case of diffuse reflection (dry surface), part of the light returns to the direction of the vehicle, thus a relatively high brightness image is captured by the sensor. Whereas, in case of specular reflection (frozen, iced surface) almost no light is returned compared to that of diffused reflection case.

Thus, the brightness image captured by the sensor is supposed to be extremely low. However, specular reflection occurs only when some conditions are fulfilled. In order to understand these conditions, we need to explain some optical definition terms. 1) Incident angle: angle formed between the laser beam irradiating on the road surface and the line perpendicular (or normal) to the surface at the point of irradiation; 2) Incident plane: the plane which contains the normal and incident irradiation; 3) Light polarization: light can be thought of as an electromagnetic wave. The s-polarization and p-polarization are the light oscillating perpendicularly and parallel to the incident plane, respectively. Whether the detector module would be mounted around the car roof mirror or bottom of front grill, incident angles on the road surface will be around 87 degrees and 89 degrees, at speed of 30km/h and 100km/h, respectively for a sufficient warning time of 4 seconds. The reflectance of s- and p-

polarized waves have been calculated based on the Fresnel equations and plotted as shown in Fig. 4. The reflectance starts to split at an incident angle of about 20 degrees, and s-polarized wave reflectance is much higher than to that of p-polarized wave in the range of 70 degrees to 90 degrees.

Thus, if only s-polarized beam is irradiated, the reflectance [%] at 30km/h and 100km/m will be around 78% and 92%, respectively. Those values demonstrate that specular reflection can be achieved when the following conditions are fulfilled: 1) irradiation of s-polarized wave, and 2) incident angle above 87 degrees.

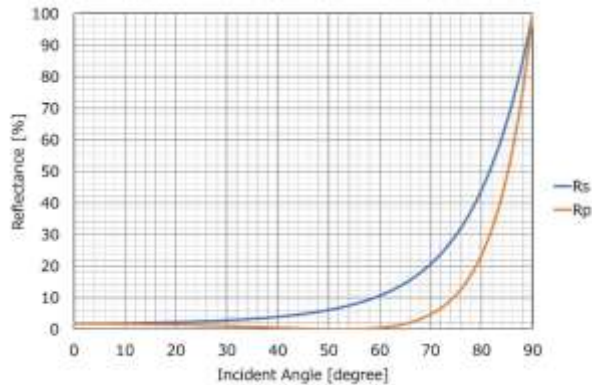


Fig. 4 Graph of s- and p-polarized beam reflectance for refractive index of 1.309 (water).

Experimental results of proposed detection system are shown in Fig. 5 and Fig. 6. The micromirror has been driven near to the resonance frequency for both axes, so that a Lissajous scanning has been performed. From these results the detection principle has been verified.



December 19, Online

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