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APPLIED USAGE OF ACCELEROMETER SENSORS AND GYRO SENSORS

***Abstract:** Nowadays we cannot imagine the modern world without the diverse integration of electronics into our lives, and sensors are one of the parts of electronic devices. This article tells about the application of modern sensors on the example of three foreign studies. The study examines the general scheme of each device without a deep analysis of the technical component. In addition, data on the main areas of application of these devices and the results of their use is obtained.*

***Keywords:** analog sensors, action recognition, microcontrollers, accelerometers, gyro sensors.*

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ПРИКЛАДНОЕ ИСПОЛЬЗОВАНИЕ АКСЕЛЛЕРОМЕТРОВ И ГИРОДАТЧИКОВ

***Аннотация:** Современный мир невозможно представить без разнообразной интеграции электроники в нашу жизнь, и одной из частей электронных средств являются датчики. Данная статья рассказывает о*

применении современных акселерометров и гиродатчиков на примере трех зарубежных работ. В исследовании рассмотрена общая схема работы каждого устройства без глубокого анализа технической составляющей. Также получены данные по основным областям применения этих устройств и результаты их использования.

Ключевые слова: *аналоговые датчики, распознавание действий, микроконтроллеры, акселерометры, гиродатчики.*

We live in an extraordinary time. The areas of our life, where modern technologies are used, are broader and broader every year. The machine learning, the Internet Of Things (IOT), cloud services, smart home systems and etc. – are already a common part of our life. The usage of some technologies find unusual and, at first glance, non-obvious application. Varied sensor sets have got widespread usage. One of popular sets of sensors, which is used almost everywhere, is a set of an accelerometer sensor and a gyro sensor.

The relevance of the research lies in the fact that sensors, which are reviewed in this article, are a good solution of a big number of modern problems in different fields of our life, we need to know what they are used now for and how we can use them in the near future. Medicine, military industry, automotive industry, and management – are a small part of the areas where accelerometer sensors and gyro sensors are used. In this paper I'd like to review three articles, where modern applied usage of accelerometer sensors and gyro sensors is described and analyze them.

The purpose of the study is to analyze application areas of accelerometer and gyro sensors and identify advantages and disadvantages of such solutions.

To achieve the goal, the following research objectives should be solved:

- Find information of sensors usage areas;
- Look into methods of sensors usage;
- Explore and compare the results of the survey;
- Analyze the information, which was received;
- Draw a conclusion.

The first article is about how to solve the safety problem in the Korean construction industry. One of the main problems is the lack of a safety helmet. This article describes the creation of a system for monitoring the correct wearing of a safety helmet by workers at construction.

The developed system uses an accelerometer, a microcontroller, a real time clock (RTC) and a special algorithm for processing data from the sensor [Figure 1]. The accelerometer acts as a sensor with which you can get information about wearing a helmet. The accelerometer data is sent by Bluetooth to the phone, and from it to the server, where a special algorithm analyzes data. This algorithm can classify whether the helmet is worn correctly and the type of work of the worker at the moment.

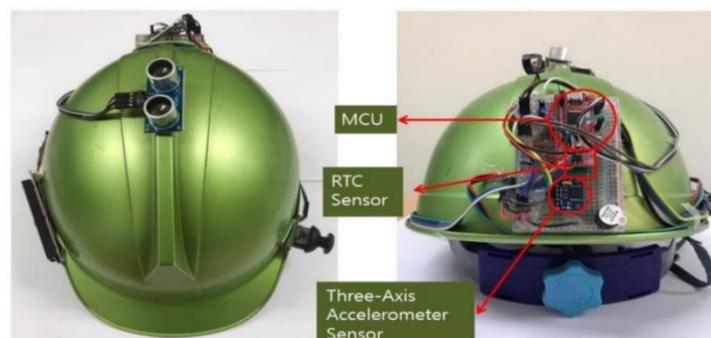


Figure 1 – The device prototype

The mean recognition rates for the 11 considered typical worker activities at construction sites are 97% for properly wearing the safety helmet and 98 % for not wearing the helmet, which indicate good classification performance. A high accuracy of 97% was also achieved for the data obtained when improperly wearing the helmet.

The authors conclude that this device will contribute to the prevention of construction accidents by monitoring if or not workers properly wear safety helmets.

The authors of the article «Stride counting in human walking and walking distance estimation using insole sensors» offer a new approach to addressing a problem of the accuracy of walking distance tracking. This objective was released by developing a new system.

Authors compared researches similar to this. In different solutions of this objective, we can see several ways of implementation a hardware part of a system, which can monitor a walking distance. All the variants of implementation are not really

good. Why do authors think so? The reason is that in previous researches devices were affixed to a human body or to shoes, that was not suitable for daily use. So, authors decide to develop a new system, which can be more suitable without losing accuracy and they started a developing a special insole. The main advantage of this method is convenience: all people wear shoes daily and changing the insole is easier than using a special device, which is attached to your body.

The insole – is a special software and hardware system [Figure 2]. The hardware part includes: a triaxial accelerometer, eight pressure sensors attached to it, and a microcontroller (MCU) kit supporting Bluetooth connection to transmit information to smartphone.

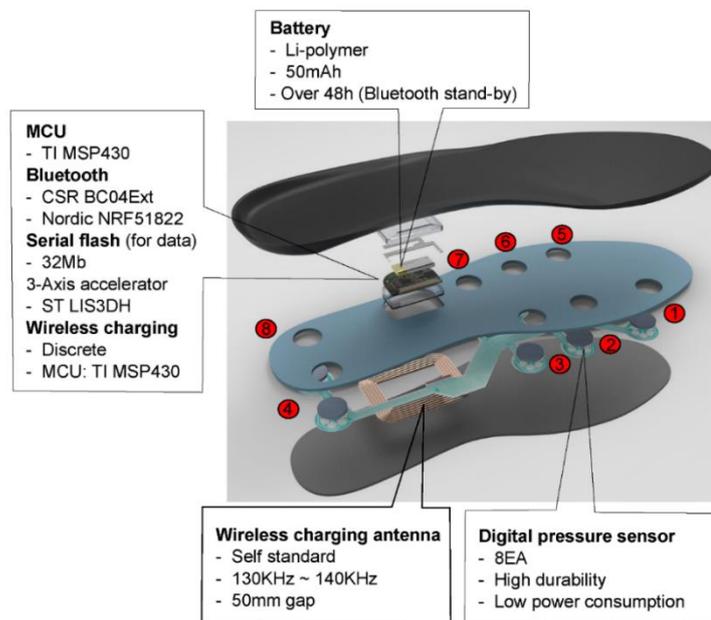


Figure 2 - The insole scheme

System work consists of three main steps:

- There are two phases in person's leg motion [Figure 3], they are the stance phase and the swing phase and in the first step system recognizes them by accelerometer sensor.

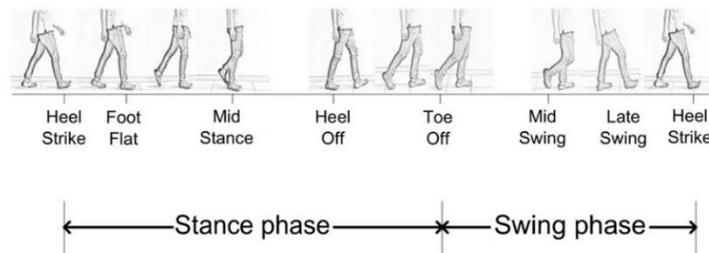


Figure 3 - Phases of the gait cycle

The stance phase includes heel strike, foot flat, mid stance and heel off phases. The swing phase includes toe off, mid swing and late swing.

- Then system corrects accelerometer sensors data by pressure sensors data to get more accuracy information of motion phase;
- In the third part a special algorithm processes corrected data. It counts numbers of steps and a walking distance.

This system shows good results: the recognition errors are about 4.5% that is nearly perfect.

Devices similar to this are important for us: with the help of this device we can examine and diagnose diseases of a musculoskeletal system. Moreover, it can be used to control patient's rehabilitation and the period of adaptation to the prosthesis.

The article «Multi-sensor data fusion in a real-time support system for on-duty firefighters» describes the creation of a system, which can reduce numbers of firefighter's injurers and deaths. Authors tell us about the problem of firefighter's injuries and deaths, describe some variants of a solution to the issue and analyze disadvantages.

The main problem in this field is a lack of survey: there is a large number of developments, that only looks like a solution to a firefighter's safety issue (e.g. there are systems, which can recognize the fall of a person, but these systems are suitable for old people, because they work insufficiently quickly). So, the authors decided to develop a new device.

The hardware part includes a microcontroller, a transmitter for communication with other firefighters and some sensors, such as a barometer, a magnetometer, an accelerometer and a sensor of gases [Figure 4]. The microcontroller acts as a data processing system, also it manages data receipt from other firefighters and data transmission to them. The set of a magnetometer, an accelerometer and a barometer are needed for analysis of firefighter’s activity. The gases sensor is used as an «assistant» for firefighter’s oxygen system. The software part is a special program, which identifies a fall, a lack of a motor activity and some types of a firefighter’s activity. Moreover, it analyzes a chemical composition of the air and will signal if the concentration of gases is more than an allowable level.

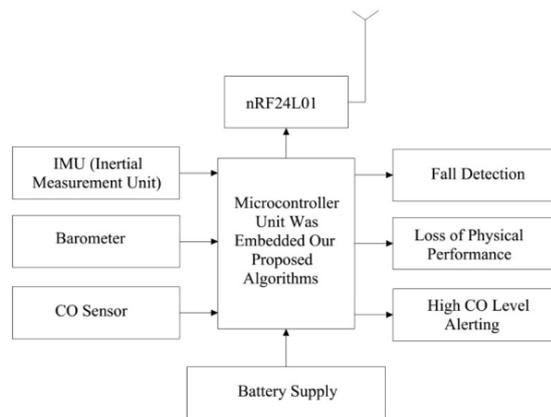


Figure 4 – Block diagram of the proposed system

The errors of recognition of a lack of motion are about 3% — it’s a good result.

The firefighting service – is one of the most important government rescue services and such devices can help to reduce numbers of firefighter’s injurers and deaths.

After the review of three articles, we see that gyro sensors and accelerometer sensors are widespread in various fields of our life.

The first article shows us the unusual solution of the workers deaths problem. I think that devices similar to this are important and useful not only for Korea, but for our country too. The “Smart insole” from the article number two can find applications in medicine, e.g. to control patient’s rehabilitation or prosthesis adaptation period. Authors of the article number three told us about firefighter’s support system, such systems will be applied in all countries to reduce the number of disasters.

All systems, which the articles represent, have many ways to be used. I have suggested the most obvious and already known ways of usage of these systems. I hope that such inventions will continue to appear on our planet. Modern problems require modern solutions and we can solve them with the help of similar sensors.

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