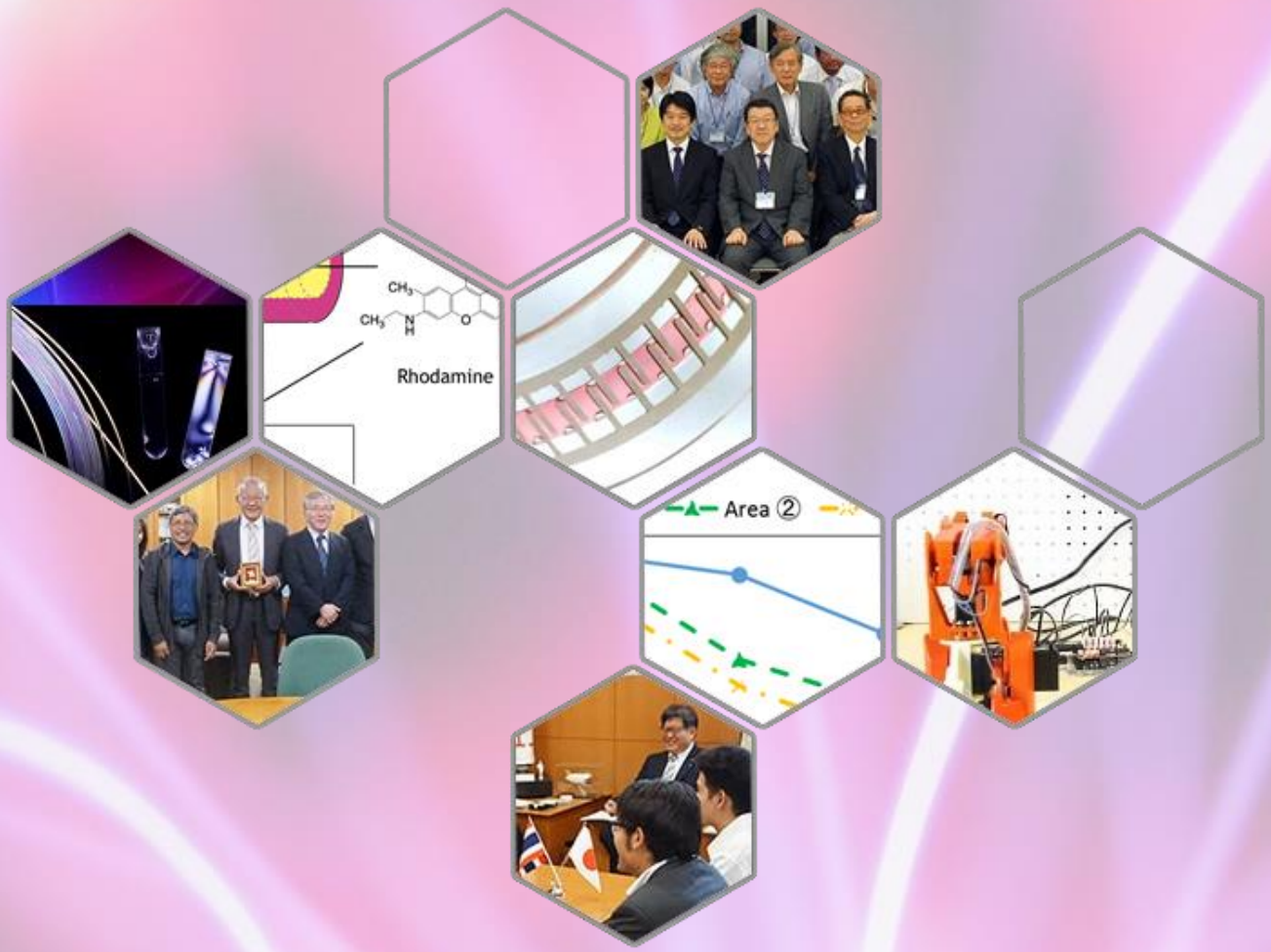
The University of Electro-Communications

UEC e-Bulletin

Updates on research, innovation, and events at UEC:
Unique and Exciting Campus in Tokyo

Vol.24, December 2019



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Basic studies and application of plastic optical fibers

Rei Furukawa
Associate Professor, Department of Engineering Science, The University of Electro-Communications, Tokyo.

Rei Furukawa and her colleagues are conducting research on plastic optical fibers. "We fabricate our own fibers, for example using unique monomer compositions, by adding dopants, dyes, fluorophores, nano-crystals, for example," explains Furukawa. "We are investing new possibilities of plastic-based optical fibers."

Plastics, such as water bottles, are transparent, flexible, and can tolerant greater outer forces compared to glass. Furukawa and her group research are using this elastic nature of polymers to make fiber-optic strain sensors with higher sensitivity and new detection mechanisms.

"We are developing fiber-optic strain sensors that allow the user to literally see stress using their own eyes instead of relying on equipment such as spectrum analyzers."

Furthermore, another feature is that if someone has any interesting small molecules or particles, then it is possible to just dope it into the plastic optical fiber core. "In that way, you can see the performance of your material over an optical path in the range of meters," says Furukawa.

Furukawa is collaborating with civil engineers who are close to workers on highways and chemical industries. "Sometimes they bring us new ideas for using plastic fiber that we have not thought about. We are totally open for collaboration with researchers and industrialists throughout the world."

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Stretchable electric pumps for next-generation soft robotics

Soft robots that are composed of compliant materials, offer important advantages over conventional rigid robots, such as simplified body structure and control as well as high robustness and versatility.

Stretchable pump consisting of soft materials
(Credit: Vito Cacucciolo / 2019 EPFL)

Fluidic soft actuators are one of the most widespread technologies in soft robotics. However, fluidically driven systems require rigid pumps or compressors that make the system complicated and bulky.

Jun Shintake at the University of Electro-Communications, Tokyo, and colleagues at the Shibaura Institute of Technology, Japan, and at Swiss Federal Institute of Technology in Lausanne, Switzerland have developed a soft and stretchable pump that is made of compliant materials.

The device works by the principle of electro-hydrodynamics that transform electric energy to the kinetic energy of fluids. Through experiments, the soft pump showed specific pressure and flow rate comparable to traditional rigid compressors. Moreover, several soft robotic applications using the same technology were demonstrated: a textile glove for on-body thermal regulation and fluidic muscles. These results illustrate the high potential of the device developed in this research as key elements for the creation of next-generation soft robotic systems.

References

- Authors: Vito Cacucciolo, Jun Shintake, Yu Kuwajima, Shingo Maeda, Dario Floreano, Herbert Shea
- Title of original paper: Stretchable pumps for soft machines
- Journal, volume, pages and year: *Nature*, vol. 672, no. 7770, pp. 516-519
- Digital Object Identifier (DOI): 10.1038/s41586-019-1479-6
- Affiliations: The University of Electro-Communications, Tokyo; Shibaura Institute of Technology; Swiss Federal Institute of Technology in Lausanne

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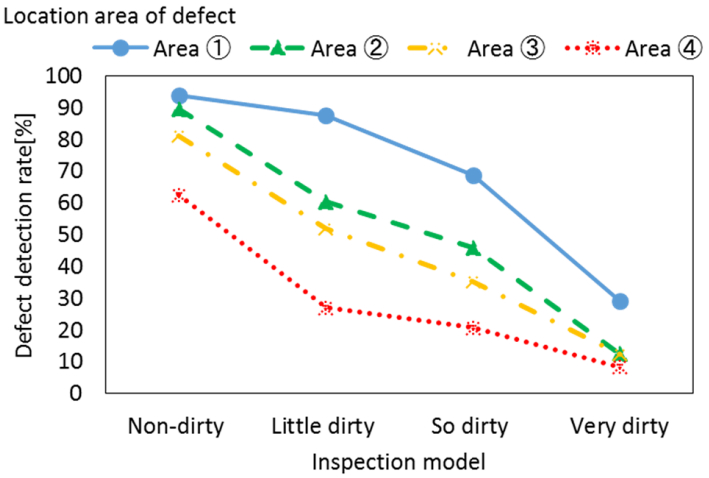
Inspecting dust on surfaces in product manufacturing: Effect of dirt on inspection surfaces on the accuracy of visual inspection

To supply high-quality products to the market, visual inspection by human senses is conducted in many manufacturing industries. It is generally recommended that visual inspection for a high-quality product be performed in a clean room.

However, in situations where the production process becomes more complex and more outsourcing in recent years, visual inspection is not often performed in a clean room because of constraints of existing equipment and economic problems.

Now, Ryosuke Nakajima at UEC Tokyo and colleagues at Aoyama Gakuin University have utilized peripheral vision to clarify experimentally the relationship between dirt levels of inspection surfaces and defect detection in visual inspection.



Relationship between dirt levels of inspection surface and defect locations.

The experiment was a three step processes: analyze images of inspection surfaces in an actual factory and then create an inspection model for dirt density based on the pixel values of the images; design experiment using dirt levels of inspection surfaces, defect locations, and defect characteristics as experimental factors; examine the effects of these factors on the defect detection accuracy with 12 subjects.

A sudden reduction in the defect detection rate was observed as the inspection surface became dirtier.

The research shows the importance of a clean inspection surface for a highly accurate visual inspection process, and it is important to take measures such as making the production process in a clean room and cleaning an inspection surface before the visual inspection process.

References

- Authors: Ryosuke Nakajima, Yuta Asano, Takuya Hida, and Toshiyuki Matsumoto
- Title of original paper: The Relationship between Dirt Levels of Inspection Surface and Defect Detection in Visual Inspection Utilizing Peripheral Vision.
- Journal, volume, pages and year: *Industrial Engineering & Management Systems* vol. **17(1)**, pp. 102-112 (2018).
- Digital Object Identifier (DOI): 10.7232/iems.2018.17.1.102

- Affiliations: Assistant Professor, Graduate School of Informatics and Engineering, The University of Electro-Communications, Tokyo.

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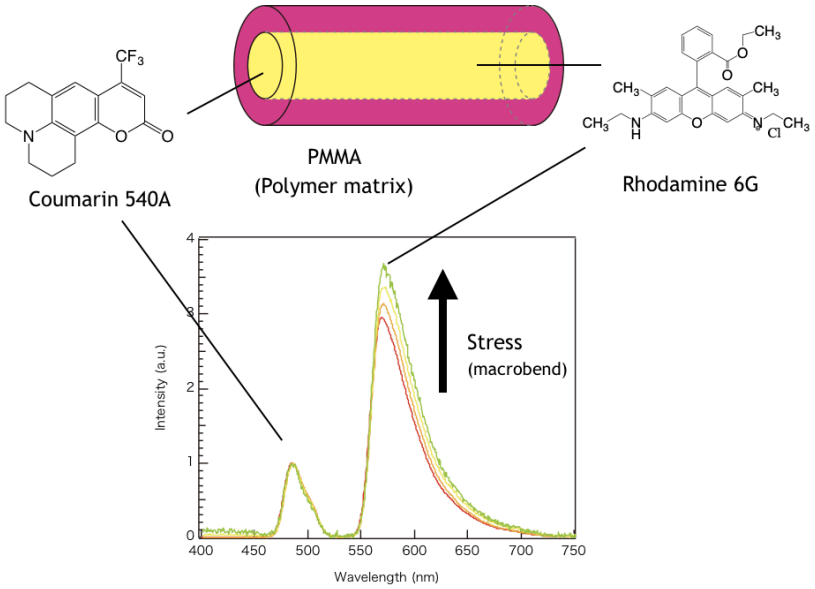
Polymer-based optical fiber for visualization of stress

Fiber-optic strain sensing is known for its ability to monitor large areas. However, most types of fiber-optic strain sensors require spectrum analysis instruments, which drastically increases the overall cost of sensor systems. In contrast, fiber-optic strain sensors such as Bragg-grating or Brillouin optical time domain reflectometers, have reliable structures that are commercially available. However, they are not widely used to support workers in high-risk construction sites.

Rei Furukawa's group at the Department of Science Engineering and collaborators have developed another type of fiber-optic strain sensor that can literally "visualize" strain. This enables an effective cost-down and is much simpler compared to conventional technology.



Transition of output spectrum of a fluorophore-doped polymer optical fiber upon applied stress.

The sensor is a polymer-based optical fiber with two fluorophores doped in its core and cladding, respectively. The polymer can support organic dopants due to its low processing temperature. The color of the output is one of the two fluorophores depending on whether the fiber is compressed or not. The two fluorophores have a large gap in their emission band so the user can observe and analyze signals with their own eyes.

The group wishes that this technology can somehow contribute to reducing accidents in construction sites.

References

[1] S. Kamimura and R. Furukawa: " Strain sensing based on radiative emission-absorption mechanism using dye-doped polymer optical fiber," *Applied Physics Letters* **11**, 063301 (2017). DOI: 10.1063/1.4998738

[2] C. Hirose, N. Fukuda, T. Sassa, K. Ishibashi, T. Ochiai, R. Furukawa: "Fabrication of a Fluorophore-Doped Cylindrical Waveguide Structure Using Elastomers for Visual Detection of Stress," *Fibers* 7 (2019) No.5, 37. DOI: 10.3390/fib7050037

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・Personal Website: http://kjk.office.uec.ac.jp/Profiles/58/0005800/profile.html

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Algorithms for enhancing security of IoT industrial control systems

Kenji Sawada
Associate Professor, Info-Powered Energy System Research Center, The University of Electro-Communications, Tokyo.

Kenji Sawada is using his expertise in control engineering to develop algorithms for freely moving objects for applications including automobiles, robots, and security and energy, using mathematical theory for optimization and signal processing.

"We are developing technology for protecting industrial equipment control systems and critical infrastructure from cyber-attacks, especially in Internet of Things (IoT) related technology," says Sawada. "Unlike information systems, control systems generally have a long operating period of 20-30 years and have limitations in that they cannot be easily shut down if attacked."

Sawada has developed an algorithm that gives security functions to industrial controllers that operate control systems equipped with actuators and sensors. The behavior of controllers is constantly monitored, and a warning can be issued in real time if it deviates from normal operation. This makes it possible to quickly detect abnormalities caused by cyber attacks. Sawada has implemented his technology in FA (factory automation) and PA (process automation) equipment and demonstrated its functions.

However, there have been reports of cyber-attacks targeting important infrastructure such as electricity, gas, and water, underscoring the need for measures to handle such issues.

"I am participating in a national project to develop technology to defend control systems against such attacks, and keep equipment running even under attack," explains Sawada. "It will be implemented in critical infrastructure supporting the facilities of the 2020 Tokyo Olympic and Paralympic Games."

In the field of energy, Sawada is conducting research on energy systems with high so-called resilience (resilient power) aimed at early restoring systems in the event of disasters such as earthquakes and floods. "We are exploring optimal control methods for power systems using autonomous distributed control methods that distribute and autonomously process control systems connected to networks," says Sawada.

Important research papers

1. A. Mochizuki et al, "On Experimental Verification of Model Based White list for PLC Anomaly Detection", 2017 Asian Control Conference - ASCC 2017, Gold Coast 17 - 20 December 2017.
   Abstract
   Recently, defensive countermeasures of controller are important because cyber-attacks on the control system are growing highly. This paper proposes an anomaly detection method of white list using PLC

(Programmable Logic Controller) as one of the countermeasures of controller. This paper introduces a white list design technique which models normal behaviors of field devices via Petri net and converts the white list model to ladder diagram. It allows PLC to detect the cyber-attack.

2. K. Hata et al, "Collaborative Model-Based Fallback Control for Secured Networked Control Systems", IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society
DOI: 10.1109/IECON.2018.8592923
Abstract
The authors have proposed the Fallback Control System (FCS) as a countermeasure after cyber-attacks happen in Industrial Control Systems (ICSs). For increased robustness against cyber-attacks, introducing multiple countermeasures is desirable. Then, an appropriate collaboration is essential. This paper introduces two FCSs in ICS: field network signal is driven FCS and analog signal driven FCS. This paper also implements a collaborative FCS by a collaboration function of the two FCSs. The collaboration function is that the analog signal driven FCS estimates the state of the other FCS. The collaborative FCS decides the countermeasure based on the result of the estimation after cyber-attacks happen. Finally, we show practical experiment results to analyze the effectiveness of the proposed method.

Further information

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Sakura Science Plan Visiting Students Pay a Courtesy Visit to Mr. Hagiuda Koichi, the Minister of Education, Culture, Sports, Science and Technology (MEXT) during Their UEC Visit

With the implementation of the Sakura Science Plan supported by the Japan Science and Technology Agency, a group of ten visiting students and one supervisor from King Mongkut's University of Technology North Bangkok (KMUTNB) in Thailand, one of our prestigious partner universities, was invited to our campus for 7 days between October 20 and October 26 to conduct research exchanges, tour laboratories, engage in student interaction, give a presentation at the symposium, and explore the Japanese culture.

During their visit, they were commemorated as the 30,000th visiting students and had the opportunity to pay a courtesy visit to Mr. Hagiuda Koichi, the minister of MEXT on October 23, 2019. One KMUTNB student told Mr. Hagiuda, "I look forward to seeing what advanced technology is being explored at Japanese universities and how students are working in the research field." Another said, "I hope to return and study at Japanese universities as an international student in the future." Responding to these motivated comments, Mr. Hagiuda heartily encouraged them by saying, "Science and technology offer many opportunities for cross-border cooperation. I hope that all of you will continue to play active roles in becoming a bridge between two nations."

Through the exchange with Mr. Hagiuda, the relationship between KMUTNB, our university, and Japan was further deepened. On the last day, the group paid a courtesy visit to UEC President Fukuda and Dr. Nakano, a member of the UEC board of directors, and reported that visit to Japan was a fruitful experience.

Meeting with the Minister Mr. Hagiuda

Group photo with Mr. Hagiuda

Group photo in the UEC President's office

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UEC holds The 1st ECTI - UEC Workshop and The 6th UEC Seminar in ASEAN, 2019

On September 6-7, 2019, "The 1st ECTI - UEC Workshop on AI and Applications" (Sep 6) and "The 6th UEC Seminar in ASEAN, 2019" (Sep 7) took place at Rajamangala University of Technology Krungthep in Bangkok, Thailand. Eminent researchers, executive officers and staffs of UEC partner universities, governmental agencies and industry from Thailand and other ASEAN countries came together for the workshop and the seminar.

The 1st ECTI - UEC Workshop Group Photo

The 1st ECTI - UEC Workshop on AI and Applications was jointly organized by the professors of ECTI association and the University of Electro-Communications (UEC). 14 invited talks and 25 poster presentations were given by researchers in AI and the related fields and students from ASEAN institutions and UEC. About 70 participants of the workshop held active discussions on research topics in AI and its applications during the workshop.

The 6th UEC Seminar in ASEAN Group Photo

UEC Seminar in ASEAN has been annually hosted by UEC ASEAN Research and Education Center (UAREC) of UEC since 2015. The 6th UEC Seminar was held this year in the aim to strengthen networks with industry, government, and academia in cooperation with ECTI Workshop. Prof.

Presentation from Vice president Abe

Ishibashi, the Director of UAREC gave the opening address, and then guests from UEC partner universities and governmental agencies gave guest speeches. Invited speakers and UEC professors gave presentations for UEC activities including cooperation programs with ASEAN institutions: Global Alliance Laboratory (GAL) with partner institutions in Hanoi; and Summer Short Exchange Training Program with partner universities in Thailand. Then, executive officers and experts form industry and government gave speeches and the seminar was closed by Prof. Abe, the UEC vice president. More than 140 participants in total attended the workshop and the seminar.

New UEC Alumni Ambassadors

UEC plans to hold the 7th UEC Seminar in ASEAN in Bandung, Indonesia to further enhance international joint research, exchange programs and industry-academia-government collaboration in ASEAN region.

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UEC signs general agreement with National Taipei University

As of 7 August, 2019, the University of Electro-Communications (UEC) has singed general agreement with National Taipei University, Taiwan, to promote further international collaboration between the two universities.

National Taipei University is located in New Taipei City. It has six faculties namely: electrical informatics, law, commerce, public works, social sciences and humanities. The university places high priority on international cooperation having international collaborative research and exchange programs with more than 100 overseas universities and research institutes.

This opportunity will contribute to further strengthen international research and educational cooperation between the two universities.

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3rd International Union of Radio Science, Japan Radio Science Meeting 2019(URSI) held at UEC Tokyo

President Fukuda gives the opening speech

The 3rd International Union of Radio Science, Japan Radio Science Meeting 2019　(URSI) was held at the University of Electro-Communications campus from 5-6 September 2019. This conference will further revitalize Japan's URSI-related activities under URSI, an international organization that actively engages in activities to contribute to the development of radio science, and will encourage young researchers to taken an interest in radio science.The number of registered registrants was ~ 200, and many papers were presented. Prof. Yagitani (URSI-JRSM 2019 Conference Chair), Prof. Shibata (President, IEICE Electronics Society), Prof. Ando (President, URSI), and President Fukuda (President of the University of Electro-Communications) and others gave opening speeches.


Group photograph

At the main venue, Prof. Hayakawa (Professor Emeritus, UEC Tokyo) gave a keynote lecture entitled "Study of Radio Noise for 45 years" and there were also 10 invited lectures from 10 commissions. Oral presentations were given in parallel sessions in the afternoon of each day in 10 venues for each commission.On the first day, as many as 90 poster papers were presented in the lobby of the main venue, and a student paper competition (SPA) was held.


Prof. Hayakawa (Professor Emeritus, UEC Tokyo) giving a key note

Furthermore, there were exhibits both from companies and universities including the UEC's Center for Space Science and Radio Engineering (SSRE). At the official conference banquet held in the UEC Tokyo, the UEC President and Executive Director Nakano and many people participated. The conference was a great success.

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Irago Conference 2019 is held at UEC campus

Group photograph of participants at Irago 2019

The Irago Conference 2019 was held on 29 October 2019 at the UEC Tokyo campus. The conference was organized by University of Electro-Communications, Toyohashi University of Technology, and Tokai University. This was 9th in this series of conferences providing a platform for networking between scientists, graduate students, and policy makers to interact and share ideas to find solutions for some the major issues of the 21st century.

President Fukuda giving a speech as the evening session

This core theme of this year's conference was "Insights into Sustainable Development Goals" and the proceedings included 5 invited speakers and more than 90 poster presentations. More than 150 participants attended the conference including the invited speakers from Spain, Italy, and Japan.

In addition to the scientists and graduate students, high students from high schools throughout Japan also participated in the conference, presenting posters and actively asking questions during the sessions.

The conference was organized in partnership STAM journal and Nitto Pharmaceutical Industries Ltd., and the evening session included speeches by guests including the teachers of the high schools.

The University of Electro-Communications (UEC) in Tokyo

is a small, luminous university at the forefront of pure and applied sciences, engineering, and technology research. Its roots go back to the Technical Institute for Wireless Commutations, which was established in 1918 by the Wireless Association to train so-called wireless engineers in maritime communications in response to the Titanic disaster in 1912. In 1949, the UEC was established as a national university by the Japanese Ministry of Education, and moved in 1957 from Meguro to its current Chofu campus Tokyo.

With approximately 4,000 students and 350 faculty, UEC is regarded as a small university, but with particular expertise in wireless communications, laser science, robotics, informatics, and material science, to name just a few areas of research.

The UEC was selected for the Ministry of Education, Culture, Sports, Science and Technology (MEXT) Program for Promoting the Enhancement of Research Universities as a result of its strengths in three main areas: optics and photonics research, where we are number one for the number of joint publications with foreign researchers; wireless communications, which reflects our roots; and materials-based research, particularly on fuel cells.

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