INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

Fiche communication Projets de recherche

<table>
<tr><td rowspan="3">PHOTO ou logo du projet</td><td colspan="2">ACRONYME (+Titre) GreenShield : Contrôle Robotisé sans Pesticides des Pestes de l'Agriculture</td></tr>
<tr><td>Responsables scientifiques INSA
Arnaud LELEVE (AMPERE) – Bruno Masenelli (INL) – Abdelaziz HEDDI (BF2I)</td><td>Coordinateur : INSA LYON – Arnaud LELEVE – LABO AMPERE</td></tr>
<tr><td>Appel à projet :
ANR PA 2017 Defi 5 - PRCE</td><td>Santé Globale et Bioingénierie</td></tr>
<tr><td colspan="2">Montant financé : 558 kE</td><td>Financeur (avec logo) : ANR</td></tr>
<tr><td colspan="3">Dates - Durée : 01/10/2017 au 31/03/2021 – 42 mois
Dates de début et fin – Durée en mois</td></tr>
<tr><td colspan="3">Partenaires : Université de Bourgogne Femto- GREEN SHIELD TECHNOLOGY</td></tr>
<tr><td colspan="3">Phrase d'accroche (non obligatoire) Vers une agriculture plus saine</td></tr>
<tr><td colspan="3">Résumé non confidentiel :
L'utilisation de pesticides nous apparaît naturelle et exclusive car notre civilisation en a dépendu depuis l'antiquité. En effet, les dommages causés par les pestes conduisent à des pertes de production de l'industrie agricole estimées entre 28 et 50% (en Afrique et Asie) de la production annuelle. Par conséquent, l'Union Européenne utilise approximativement 360 millions de kg de pesticides chaque année pour les tâches agricoles et horticoles. Cependant, les méthodes d'épandage de pesticides sont inefficaces (seulement 0,3% des pesticides répandus par épandage aérien rentrent en contact avec les pestes cibles) et ont conduit à des conséquences alarmantes pour la santé publique, l'environnement et l'économie. En 2003, les coûts annuels environnementaux et économiques relatifs à l'usage de pesticides étaient estimés au total à 10 milliards de dollars pour les USA. Dans son plan « Ecophyto », le gouvernement français a décidé de réduire de 50% l'utilisation des pesticides d'ici 2018. Malheureusement, les alternatives aux pesticides étant trop rares, cet objectif a été reporté à 2025.
Jusqu'à présent, aucune méthode technologique et polyvalente n'a été développée pour remplacer les pesticides. Les techniques de détection n'ont toujours pas recours à la spectrométrie pour détecter les pestes (elles détectent des plantes infectées, donc trop tard). L'usage de robots, en collaboration avec l'humain, est exploité dans certains vignobles pour décider où pulvériser avec des degrés d'autonomie divers, induisant une réduction de (seulement) 30% d'utilisation de pesticides (i). Certaines études proposent de détecter des pestes sur des feuilles avec une caméra, mais en raison des contraintes de détection sur-site, la plupart d'entre elles imposent des conditions d'éclairage très contraignantes.
Le projet Green Shield vise à réduire l'utilisation de pesticides en développant un module robotisé embarqué sur un véhicule (robot mobile, tracteur, …) pour combattre les pestes de cultures (invertébrés, maladies, mauvaises herbes). Ce module détectera de manière autonome les pestes par analyse spectrale et les détruira par tir laser. Embarqué sur des robots mobiles, il patrouillera dans les cultures pour scanner les plantes, collecter des données</td></tr>
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fiables concernant les pestes qui serviront à optimiser les campagnes suivantes. Ce nouveau moyen de traitement définira un nouveau paradigme de lutte « bio » contre les pestes. La faisabilité des solutions technologiques proposées dans ce projet a déjà été démontrée. En effet, par spectrométrie optique, il est possible de caractériser les espèces d'insectes avec un taux de succès supérieur à 95%. En janvier 2017, nous avons réalisé une preuve-de-concept validant la méthode de détection sur des pucerons avec un spectromètre commercial et une méthode statistique (Analyse en Composantes Principales). Concernant la méthode de destruction, son efficacité a été prouvée par des confrères sur des blattes. En 2010, une équipe a montré qu'il est possible de détruire jusqu'à cent moustiques en vol, à une distance maximale de 30m, avec un laser de type Blu-ray. La méthode de détection et destruction de pestes proposée dans ce projet a été brevetée par la société Green Shield Technology, qui en industrialisera les résultats. Elle utilise des miroirs miniaturisés rotatifs pour orienter rapidement les rayons. Elle a déjà été validée pour sur des endoscopes laser en phonochirurgie par Femto-ST, l'un des laboratoires de recherche partenaires. (i) Ron Berenstein, Yael Edan, Human-Robot Cooperative Precision Spraying: Collaboration Levels and Optimization Function10th IFAC Symposium on Robot Control, September 5-7, 2012. Dubrovnik, Croatia
Mots clés (2 max) : Robotique Agriculture
Peut-on afficher votre adresse email pour tout contact/demande sur le projet ? ☑ Oui ☐ Non
Site internet du projet : http://www.anr-greenshield.fr/

PHOTO or project logo	ACRONYM (+Title) GreenShield **Pesticide Free Robotized Pest Control in Agriculture**	
	INSA's scientific leader : Arnaud LELEVE (AMPERE) – Bruno Masenelli (INL) – Abdelaziz HEDDI (BF2I)	**Project Leader :** INSA LYON – Arnaud LELEVE – LABO AMPERE
	Call for proposal : ANR PA 2017 Defi 5 - PRCE	Global Health and Bioengineering
Funding : 558 kE		**Funding Institution (with logo) : ANR**
Dates - Duration : 01/10/2017 au 31/03/2021 – 42months *Start and end date – Duration in month*		
Partners : Université de Bourgogne Femto- GREEN SHIELD TECHNOLOGY		
Catch phrase (non compulsory) Towards a safer farming		
Non-confidential summary : The use of pesticides appears natural and exclusive to us because our civilization has relied on them since antiquity. Indeed, pest damage results in economic production losses to the agricultural industry, estimated from 28 to 50% (in Africa and Asia) of annual productions. Therefore, the European Union uses approximately 360 million kg of pesticides per year for agricultural and horticultural tasks. However pesticide application methods are inefficient (only 0.3% of sprayed pesticides from aerial application		

comes in contact with the target pest) and has led to alarming consequences in public health, the environment, and economically. In 2003, environmental and economic costs associated with pesticide use were estimated to total approximately 10 billion dollars per year in the US. In its "Ecophyto" plan, French government has decided to **reduce by 50% the use of pesticides by** 2018. Unfortunately, alternatives to pesticides being too scarce, the objective has been postponed to **2025**. So far, no purely technological and versatile method has been developed to replace pesticides. Detection techniques still do not make use of spectrometry to detect pests (they detect sick plants, so too late). For instance, in 2012, some robots have collaborated with humans in vineyards to decide where to spray with various levels of autonomy. Results showed 90% accuracy of grape cluster detection leading to 30% reduction in the use of pesticides. Some studies introduce ways to detect pests on leaves with a camera, but due to the challenges of on-site detection, most of them relied on scanning under highly controlled light conditions.

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Greenshield Project aims at reducing the use of pesticides by developing a robotic module to be embedded on a terrestrial vehicle (mobile robot, farming tractor, ...) to fight against crop pests (invertebrates, diseases, weeds). This module will autonomously detect pests using spectral analysis, and destroy them with a laser. When mounted on mobile robots, it will patrol among crop fields to scan the plants, collect accurate data regarding pests that will serve to optimize the action of robots. This new means of fighting will settle a **new sustainable paradigm of pest control** to better combat them.

The technical solutions proposed in this project have already been proved to be feasible. Hence, by way of spectrometry, one can **characterize insect species with more than 95% of correct answers, and even 80% of correct answers for subspecies identification**. In January 2017, we performed and **succeeded a Proof Of Concept (P.O.C.) study** validating this method of detection on aphids with a spectrometer off-the-shelf and a simple statistical method (Principal Component Analysis). Concerning the destruction method, its **effectiveness** has been **successfully studied on cockroaches**. In 2010, in order to fight malaria, a team showed that it is possible to destroy up to a hundred mosquitoes in flight, at a maximum distance of 30m with a Blu-Ray type laser.

In this project, the method of targeting pests for detection and destruction has been **patented by the firm Green Shield Technology** which will **industrialize the results of this project**.

It uses miniature rotating mirrors to orientate the beams very quickly. This method has already been designed for an endoscopic laser in phonosurgery by Femto-ST, one of the participating research laboratories. (i) Ron Berenstein, Yael Edan, Human-Robot Cooperative Precision Spraying: Collaboration Levels and Optimization Function10th IFAC Symposium on Robot Control, September 5-7, 2012. Dubrovnik, Croatia
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