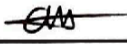


# APPENDIX A: PROJECT AGREEMENT FORM

UNIVERSITY OF HERTFORDSHIRE

SCHOOL OF ENGINEERING AND COMPUTER SCIENCE

## PROJECT AGREEMENT FORM

Name of student ASIBE, JUSTICE Signed   
CHEFACHUKWU

Name of supervisor \_\_\_\_\_ Signed \_\_\_\_\_

### MSc Project Supervision Agreement

Your individual project is an important part of your MSc course but a great deal of staff time is required to supervise all the MSc project students. You are therefore required to abide by the following agreement.

Please sign one copy and return to your supervisor, keeping the other copy for your own reference. When your project is assessed, your reliability in attending meetings with your supervisor will be taken into account as part of your project management.

I Asibe, Justice Chofachukwu (Name) 7EN1110-0105 (Course Code) agree that:

- 1 The choice of project title and supervisor is final and I will not seek to change it.
- 2 I will make every possible effort to attend regular meetings with my project supervisor on the agreed day and will arrive promptly at the agreed time. If I am unable to attend, I will inform my supervisor by phone or Email if at all possible.
- 3 I realise that my project supervisor may sometimes be unavoidably delayed after giving a lecture or supervising a laboratory and will wait at least ten minutes for him/her to return. I also accept that my project supervisor may occasionally need to reschedule my appointment due to other meetings, etc...
- 4 I will check my Email and pigeon hole every day when I sign in and will act promptly on any messages from my project supervisor.
- 5 If I go to see my project supervisor at any time and he/she is not in the office, I will leave a note under the door stating the date and time when I tried to see him/her.
- 6 If I miss an appointment with my project supervisor for any reason, I will make contact with him/her as soon as possible to arrange another appointment.

7. If I am finding the project difficult, I will see my supervisor for advice.
8. If I am making adequate progress on my own, I will still see my supervisor regularly to report my progress.
9. I understand that it is my responsibility to back up all data relating to the project on a regular basis. Loss of data resulting from technical problems will not be accepted as a mitigating circumstance.
10. I will keep a project logbook and bring it to every meeting with my supervisor.

## **APPENDIX C –PLAGIARISM STATEMENT**

I certify that the work submitted is my own and that any material derived or quoted from the published or unpublished work of other persons has been duly acknowledged.

(ref. UPR AS/C/6.1, section 7 and UPR AS/C/5, section 3.6)

**Student Full Name: Asibe, Justice Chetachukwu**

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**Student Registration Number: 17028836**

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**Signed:**



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**Date: 10/02/2020**

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MSc Project report

Feasibility study  
Advanced User Interfaces for Robot  
Teleoperation

School of Engineering & Technology  
University of Hertfordshire

Author: Asibe, Justice Chetachukwu

Student Number: 17028836

Supervisor: Prof. Salvatore Livatino

Year: 2020, Semester B

## Introduction

This project is an analysis, design and experiment based project, which explores the field of virtual reality in its application in teleoperation of mobile robots with a specific designed prototypical case scenario, a 3D telepresence, in which it is amongst its various applications, is focused on an autonomous fire extinguishing in a room. The posed case scenario depicts the remote-controlled robot in the fire scene, able to locate areas of heat and to put out the fire, without the operator physically being present, but by the advanced user interface and robot teleoperation.

The user interface (UI), in the industrial design field of human-computer interaction, is the space where interactions between humans and machines occur.[1] The goal of this interaction is to allow effective operation and control of the machine from the human end, whilst the machine simultaneously feeds back information that aids the operators' decision-making process.[1]

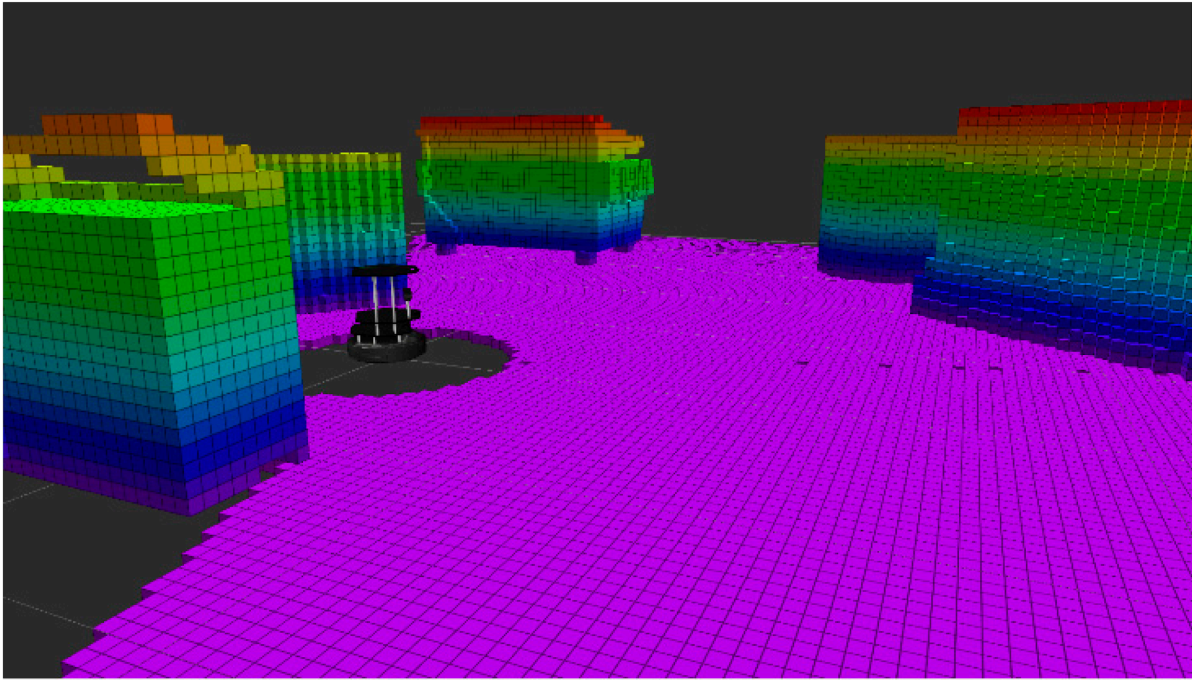
Teleoperation (or remote operation) indicates operation of a system or machine at a distance. It is similar in meaning to the phrase "remote control" but is usually encountered in research, academic and technical environments. It is most commonly associated with robotics and mobile robots but can be applied to a whole range of circumstances in which a device or machine is operated by a person from a distance.[1]

The project involves familiarization with the factors which surround Virtual reality, augmented reality, teleoperation, sensors applications and robotics, as well as previous or on-going related projects in this field, a structure built on that and a test for usability and application in today's world. Final results would be based on a statistical information and clear proposals for future innovations and embellishments on teleoperation and robotics application will be given at the end of this project.

## Technical feasibility

### Background Knowledge

Right now, teleoperated robots are mostly used in medical surgeries and military operations. Critical surgeries are made easier with teleoperated robotic arms or tools due to their ability to reach the tightest places where human hands can't operate. In military operations, teleoperated robots help to gather Intel and perform dangerous tasks like diffusing or moving an explosive. Until recently, these teleoperated robots used to be controlled by a joystick style setup or console-like controllers, pretty similar to what you have on your PlayStation, Xbox or Wii consoles. With advanced Virtual Reality and Augmented Reality technologies, teleoperated robots are entering a new spectrum – VR and AR controlled teleoperated robots.



**Figure 1. A Sensor based mobile robot, teleoperated via virtual reality**

Primitive versions of Virtual Reality and Augmented Reality emerged long ago, but lately, through modern technology, various smartphone apps and standalone consumer hardware, VR and AR are available to just about anyone. Recently, MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) came up with a VR-based controller for Teleoperated Robots using an Oculus Rift headset. Oculus, which was acquired by Facebook in 2014, has become one of the industry leaders in AR/VR technology.



**Figure 2. Teleoperated robot**

In this project however, it is to give a prototype, not of a virtual nor augmented reality but to evaluate the usability of real case scenarios, using virtual reality as a prototype, of which the case here is a fire outbreak in a room.

## The use of sensors for autonomy in robots

Modern computer vision algorithms have made navigation really easy to achieve. Most of the techniques are found already implemented in open-source computer vision libraries like OpenCV, scikit-image, imgaug etc. These implementations make it very simple to incorporate complex algorithms into your system and implement an autonomous intelligent robot. With the given environment, we literally had to pick and choose the most appropriate algorithm for feature extraction and motion generation. With the advent of deep learning however, this need was also downsized. [3]



Figure 3. Telescopy by laser sensor, using OpenCV software

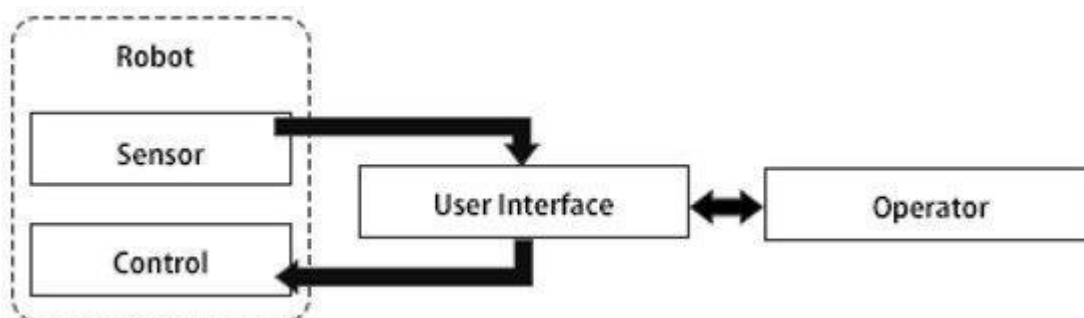


Figure 4. Flow diagram showing blackbox connection between User Interface of Robot and Operator

## Aim

The aim of this project is to gain insight about mobile robot sensors and their role in user interfaces, understand innovative concepts and experience interface assessment.

## Objectives:

- A. Gain Understanding of Mobile Robots, their applications and user interfaces.  
A mobile robot is a robot that is capable of locomotion. Mobile robotics is usually considered to be a subfield of robotics and information engineering. [2]  
Mobile robots have the capability to move around in their environment and are not fixed to one physical location. Mobile robots can be "autonomous" (AMR - autonomous mobile robot) which means they are capable of navigating an uncontrolled environment without the need for physical or electro-mechanical guidance devices. Alternatively, mobile robots can rely on guidance devices that allow them to travel a pre-defined navigation route in relatively controlled space (AGV - autonomous guided vehicle). By contrast, industrial robots are usually more-or-less stationary, consisting of a jointed arm (multi-linked manipulator) and gripper assembly (or end effector), attached to a fixed surface.[1]
- B. Comprehend Virtual Reality (VR) and Augmented Reality (AR) and their contribution to user interface in robotics  
As the name implies virtual reality pertains to an artificial reality. The environment, the elements, and the whole experience are all unreal. [3]  
Augmented reality is an enhanced version of a real-time image or a real image with an overlay of digital information. The information is layered on the image by using Smart Glasses and AR software. [3]
- C. Comprehend about popular Mobile Robot Sensors and how they support users during teleoperation  
There are different sensors ranging from the light sensors, sound sensors proximity sensors, Humidity Sensors measures Humidity; Gas sensors, voltage, gyroscope, navigation, positional, pressure to temperature sensors.
- D. Analyse previous work involving Mobile Robot Interfaces that propose VR/AR and related usability evaluations.  
This analysis would be an exploration into past and current mechatronics and robotic applications of the mobile robot interfaces which operate actively or passively with VR/AR.
- E. Design an example usability evaluation  
There would be a software based design of the user interface for teleoperation for the specific scenario selected for this project which was earlier discussed in the introduction of this report, which would be a virtual fire outbreak. This would be designed in any 3D design software such as Solid Works or CATIA. The scenery selected for this project is an

indoor fire outbreak. Necessary simulations and programming would be done using the C++ programmer and MATLAB software.

- F. Comprehend how to process experimental data and analyse and present acquired data  
A plethora of critical statistical data for this project would be carried out, both by questionnaires, person-to-person experiments, personal laboratory experiment as well as inquisition of processing skills of these acquired data from experts on the field as the need would be.

## Stages

### Theoretical

#### Literature review

1. The usability pilot study of a mechatronic system for gait rehabilitation  
11<sup>th</sup> International Conference Interdisciplinarity in Engineering, INTER-ENG 2017, 5-6 October, 2017, Tirgu-Mures, Romania.  
Alina Iliescu, Alina Magdalena Popescu, Petre Lucian Seiciu, Tadeusz Mikolajczyk, Flaviu Moldovan, Mihai Berteanu.
2. Stereo Viewing and Virtual Reality Technologies in Mobile Robot Teleguide  
Salvatore Livatino, Giovanni Muscato, Senior Member, IEEE, and Filippo Privitera  
IEEE TRANSACTIONS ON ROBOTICS, VOL. 25, NO. 6, DECEMBER 2009
3. Mobile Robotic Teleguide Based on Video Images  
Comparison Between Monoscopic and Stereoscopic Visualization  
by Salvatore Livatino, Giovanni Muscato, Salvatore Sessa, Christina Koffel, Carmelo Arena, Alba Pennisi, Daniele di Mauro, and Erinc Malkondu
4. Intuitive Robot Teleoperation through Multi-Sensor Informed Mixed Reality Visual Aids S. Livatino, D. C. Guastella, G. Muscato, V. Rinaldi, L. Cantelli, C. D. Melita, A. Caniglia, R. Mazza, G. Padula
5. Intuitive Robot Teleoperation through Multi-Sensor Informed Mixed Reality Visual Aids S. Livatino, D. C. Guastella, G. Muscato, V. Rinaldi, L. Cantelli, C. D. Melita, A. Caniglia, R. Mazza, G. Padula

### Practical

#### Preparation

- a. Get into laboratory involvements to be familiarized with mobile robots, VR and AR operations
- b. Get experts to fill questionnaire
- c. Sharpen application knowledge in CATIA, OpenCV, C# and C++ for design and simulation purposes
- d. Get a virtual structure for analysis of the usability evaluation
- e. Design 3D indoor room for fire outbreak scenery
- f. Purchase or lend necessary equipments for testing and data acquisition

#### Experiment and Evaluation

- a. Create a questionnaire for test feedback
- b. User Interface testing (20 people)

## Investigation and Scrutiny:

- a. Observation of gleaned data
- b. Visualise results and statistics
- c. Make inferences

## Summary and Review

- a. Begin dissertation and report
- b. Submit report after approval by supervisor.

# Risk

## UNIVERSITY OF HERTFORDSHIRE

### SCHOOL OF ENGINEERING and COMPUTER SCIENCE

#### APPENDIX E – RISK ASSESSMENT FORM and ETHICS Issue

**Completion of this form below is a mandatory requirement** to comply with both the current Health & Safety regulations and the University of Hertfordshire's risk assessment policy. In addition, a university risk assessment form on StudyNet must also be completed and submitted as a separate item on StudyNet with your feasibility report. If your work involve measurements on human subjects or their behaviour, the proposed work must be submitted for approval to the Ethics Committee before work proceeds.

**For every new activity undertaken in the school's laboratories, workshops or any area<sup>\*</sup> where it is deemed a requirement to risk assess an activity, a new form must be completed.** The name and signature of the person assessing the risks and those undertaking the activity, which has been assessed, must be clearly evident on the form, **so as to indicate that all parties understand the risks involved. Some activities may be off site. These activities must in turn be assessed if no appropriate system is in place.**

---

1/ Name of assessor. / Academic supervisor.

(Must be a responsible and appropriate member of staff.)

---

2/ Name of person (s) undertaking activity.

Asibe Justice Chetachukwu

---

3/ Brief description of activity – Project Title

Advanced User Interfaces for Robot Teleoperation

---

Use an additional sheet if required

4/ Location of activity: University of Hertfordshire

~~5/ Does the activity involve experimental work on human beings or use of questionnaires?  If either of these applies seek ethical guidance.~~

---

6/ Overleaf you will find a list of possible risks to guide you in your risk assessment of the activities to be undertaken. There may however be additional risks to consider! Some specialised areas have unique risks; you need to be sure what these are. Consult the local specific risk assessment and staff for advice. However you may need in addition to take procedural guidance by referring to Croner's Risk Assessment publication, section 10/95 'Risk assessment in university' (copy in Technical Manager's office).

Please use the tick boxes, and indicate with care in the panels 8 through 10 your comments.

Finally please ensure both you the assessor and the person (s) undertaking the activity sign the form overleaf, not to do so makes the whole risk assessment process invalid.

7/ Use the tick boxes to indicate what hazards are associated with the activity described overleaf in panel 3/.

Chemical agents.	<input type="checkbox"/>	Fire.	<input type="checkbox"/>	Non-ionising radiation	<input type="checkbox"/>
Compressed / liquefied gases.	<input type="checkbox"/>	Gases and fumes.	<input type="checkbox"/>	Noise.	<input type="checkbox"/>
Confined spaces.	<input checked="" type="checkbox"/>	Hand tools.	<input type="checkbox"/>	Pressure systems & vessels.	<input type="checkbox"/>
Cryogenic agents.	<input type="checkbox"/>	Hazardous materials.	<input type="checkbox"/>	Repetitive handling	<input type="checkbox"/>
Display screen equipment.	<input checked="" type="checkbox"/>	Ionising radiation.	<input type="checkbox"/>	Rotating /moving parts.	<input type="checkbox"/>
Dust.	<input checked="" type="checkbox"/>	Lasers.	<input type="checkbox"/>	Sharps.	<input type="checkbox"/>
Electricity.	<input type="checkbox"/>	Lifting equipment.	<input type="checkbox"/>	Slips, trips & hazards.	<input type="checkbox"/>
Falling objects.	<input type="checkbox"/>	Machine tools.	<input type="checkbox"/>	Vacuum systems.	<input type="checkbox"/>
Falls from height.	<input type="checkbox"/>	Manual handling.	<input type="checkbox"/>	Vehicles.	<input type="checkbox"/>
	<input type="checkbox"/>		<input checked="" type="checkbox"/>		<input type="checkbox"/>

8/ Specify any additional risks and / or qualify those indicated in tick boxes.

None

9/ Explain in detail what specific safety precautions must be observed to minimise the risks detailed above.

Normal laboratory and university safety procedures and rules must be obeyed while students are in the laboratory (details can be found in the university safety handbook). None

An additional sheet may be required

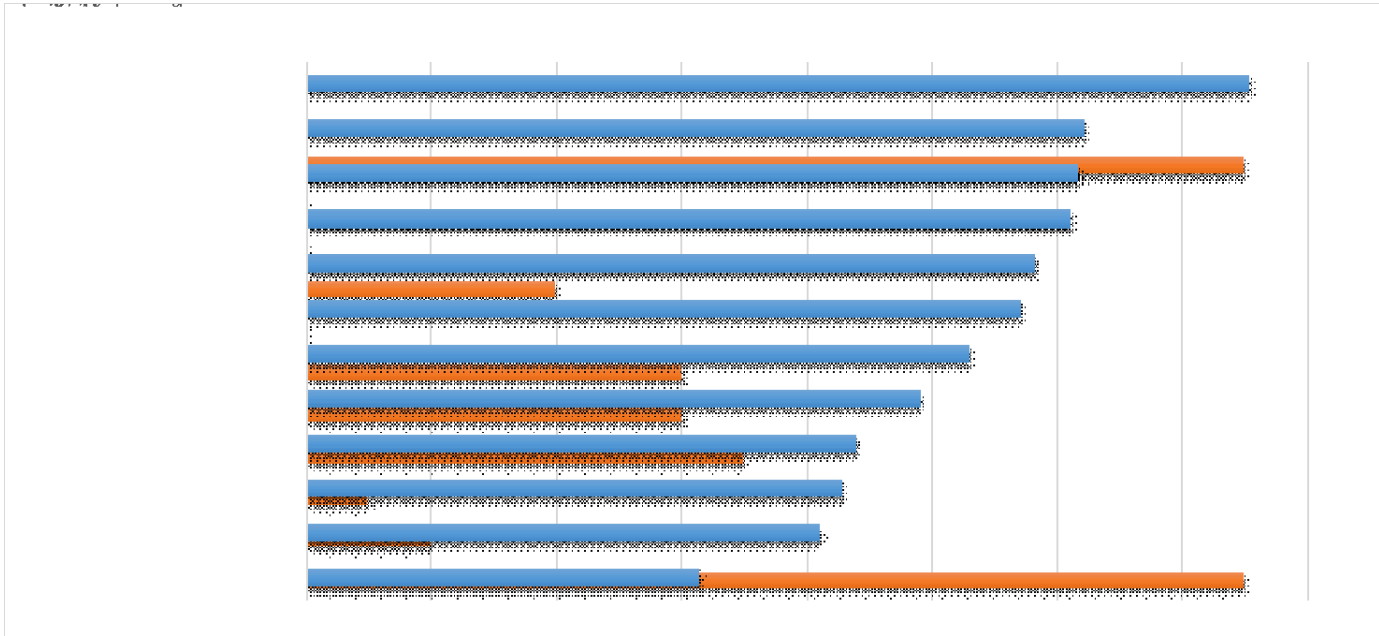
10/ Specify any training or supervision required. None

.....

## Time Plan

<b>Task</b>	<b>Duration (days)</b>	<b>Start</b>	<b>End</b>
Literature review	15	14/02/20	29/02/20
Laboratory involvement	3	2/03/20	4/03/20
Getting experts to fill questionnaire	2	5/03/20	6/03/20
CATIA, C#,C++ learning	7	7/03/20	14/03/20
Virtual design	7	16/03/20	22/03/20
3D Indoor	7	23/03/20	29/03/20
Purchase equipment	1	30/03/20	30/03/20
Experiment and Evaluation	5	1/04/20	5/04/20
Investigation	1	6/04/20	6/04/20
Inferences	1	7/04/20	7/04/20
Dissertation	15	8/04/20	23/04/20
Submit Report	1	1/05/20	1/05/20
Total days			

## Gantt Chart



## References

1. [https://en.wikipedia.org/wiki/User\\_interface](https://en.wikipedia.org/wiki/User_interface) , <https://en.wikipedia.org/wiki/Teleoperation>
2. "[Information Engineering Main/Home Page](http://www.robots.ox.ac.uk/)". *www.robots.ox.ac.uk*. Retrieved 2018-10-03.  
<http://www.robots.ox.ac.uk/>
3. [https://www.vital.enterprises/blog/post/171629643427/augmented-reality-virtual-reality-and-mixed?gclid=CjwKCAiAvonyBRB7EiwAadauqVAvrNszifZ8O8iY99PyIxxhufR9Nf1io0jptRP4onT-zQMKSsrNipBoC9XkQAvD\\_BwE](https://www.vital.enterprises/blog/post/171629643427/augmented-reality-virtual-reality-and-mixed?gclid=CjwKCAiAvonyBRB7EiwAadauqVAvrNszifZ8O8iY99PyIxxhufR9Nf1io0jptRP4onT-zQMKSsrNipBoC9XkQAvD_BwE)
4. [http://www.robotplatform.com/knowledge/sensors/types\\_of\\_robot\\_sensors.html](http://www.robotplatform.com/knowledge/sensors/types_of_robot_sensors.html)