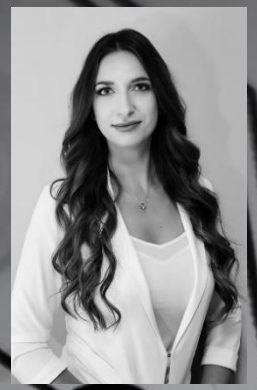
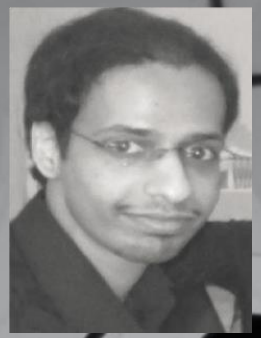
# Eye Gaze-Based Human Error Prevention System: Experts vs. Non-Experts

**Oksana Kilik**
**oksana.kilik@ontariotechu.net**
Faculty of Business & Information Technology,
Ontario Tech University,
Ontario, Canada



**Dr. Abdulaziz Almehmadi**
**abdulaziz.almehmadi@ontariotechu.net**
Faculty of Computing & IT, SNCS Research Center,
University of Tabuk,
Tabuk, Saudi Arabia

**Dr. Khalil El-Khatib**
**Khalil.el-khatib@ontariotechu.net**
Faculty of Business & Information Technology,
Ontario Tech University,
Ontario, Canada

# AGENDA

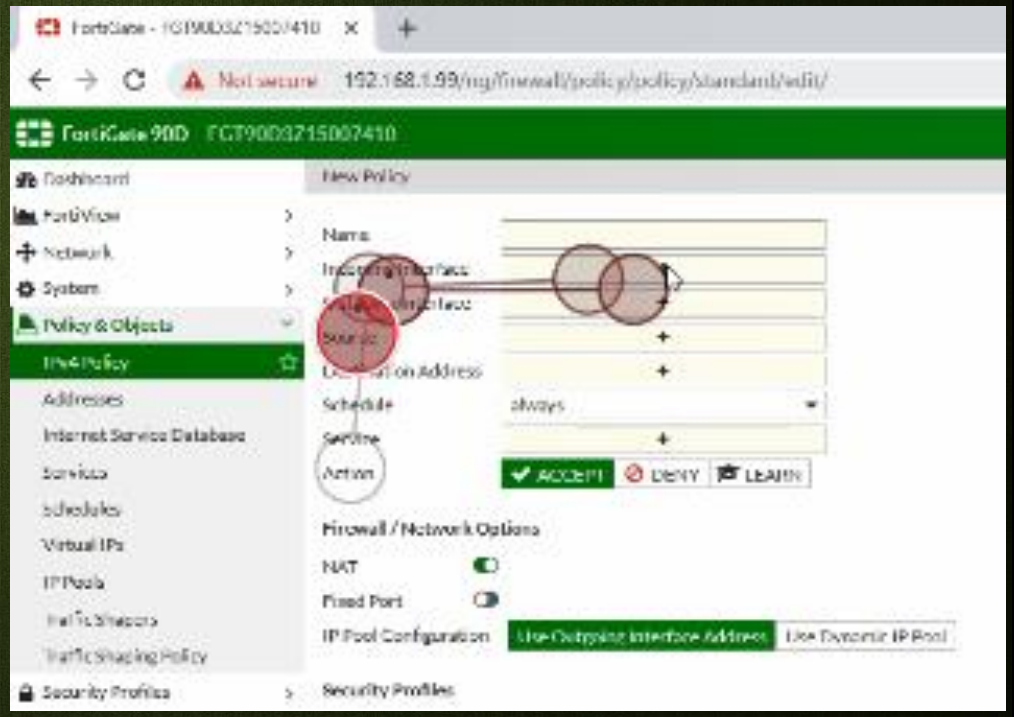
- Background on Eye Gaze Behavior and Eye Tracking
- Hypotheses
- Experiment Design
  - Tobii Pro Nano Eye Tracker
  - FortiGate-90D Firewall
  - Google Form Questionnaire and Two Network Configuration Tasks
- Observations & Findings
- Proposed Model for Human Error Prevention

# BACKGROUND ON EYE GAZE BEHAVIOR

- Gaze Behavior: the way an individual uses their vision to extract relevant information from the environment to produce an optimal action

- Visible field of view vs. attention
  - What to capture in high resolution or observe in fine detail?

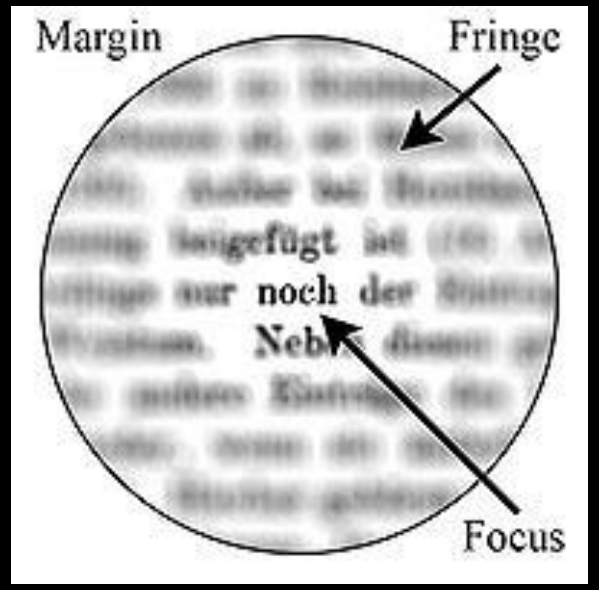
  - Fixations: when gaze remains stable on an area of interest
  - Saccades: rapid eye movements that typically occur when moving from one fixation location to another
  - Dwells: an individual's visual visits to an area of interest, where each visit is a dwell



# Spotlight Theory

## Michael I. Posner, 1980

- Attention is limited in spatial extent; spotlight
  - Independent of eye movement; parafoveal vision
- Research suggests that perceptual learning could enlarge an individual's perceptual span
- Saccade: The eye movement from one area of interest to the next across the perceptual span




# Attenuation Filter and Dictionary Units Theory

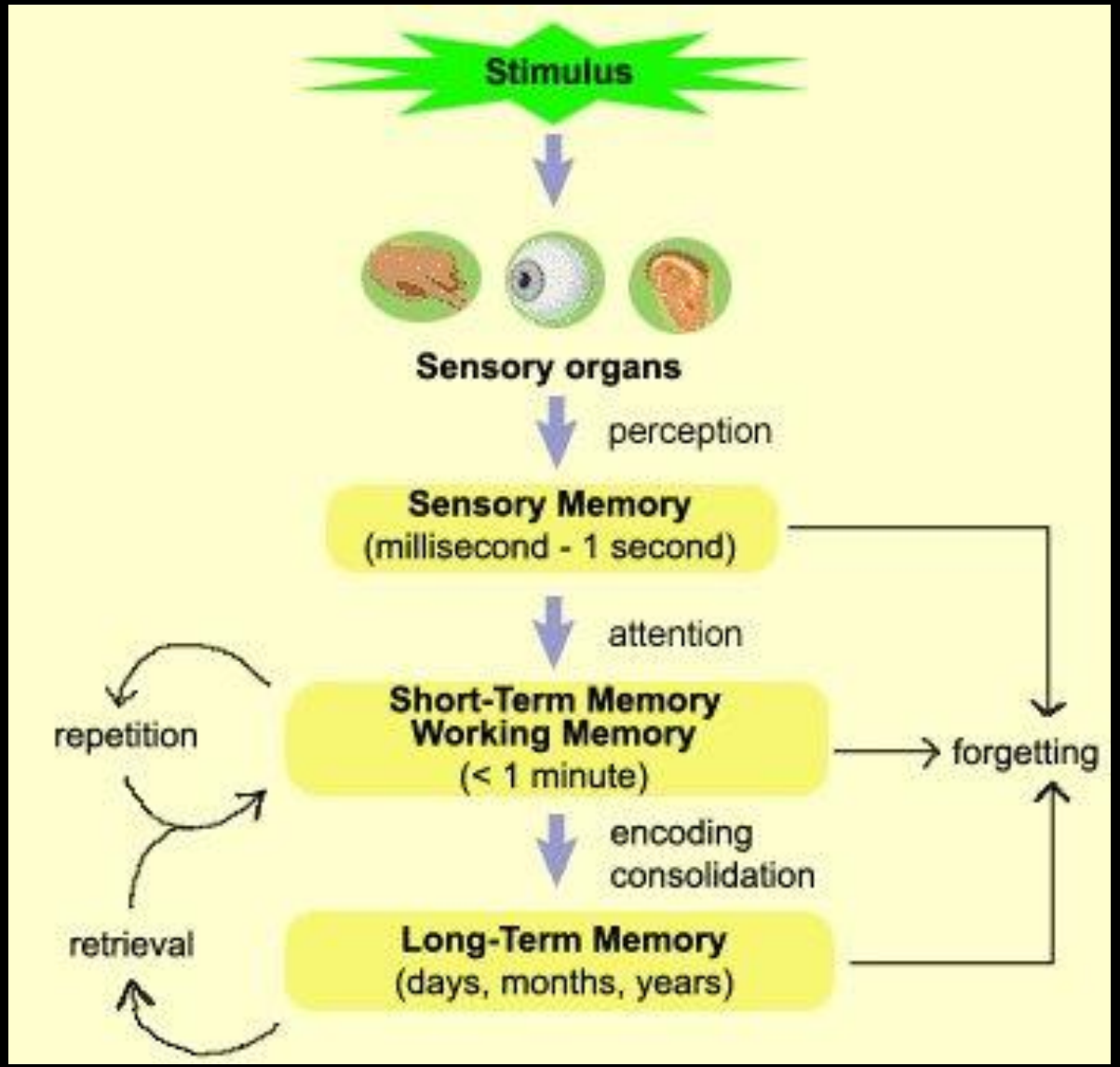
## Anne Treisman, 1960s

- Attenuation Filter: the selection of sensory messages to filter out unwanted information so that attention is drawn to the necessary areas
- Dictionary Units: individual processes the selected information based on its importance, relevance and context to generate areas of interest
- Higher fixations in an area = area requires greater attention

# Long-Term Working Memory Theory

## Ericsson and Kintsch, 1995

- Working Memory: the temporary storage of information that is being processed for any cognitive task(s); Ericsson refers to this temporary storage as short-term working memory
- Ericsson introduces long-term working memory: information stored in stable form and accessed when presented with sufficient retrieval cues
  - Experts able to act proactively with skilled performance



# HYPOTHESES

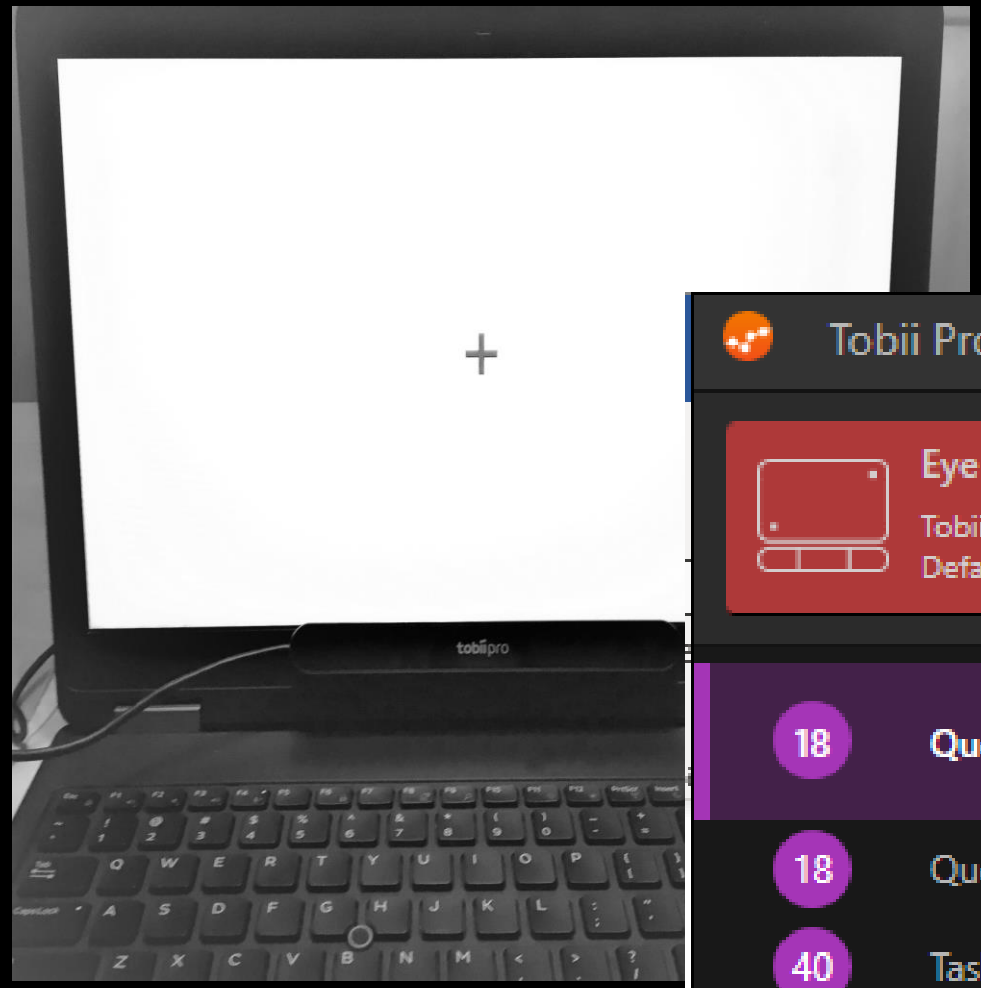
***Main Hypothesis:*** *Experts have different eye gaze behavior when compared to non-experts*

***Hypothesis 1: Spotlight theory on parafoveal vision:*** experts are expected to have less saccades in comparison to non-experts with a possibly higher amplitude of saccades

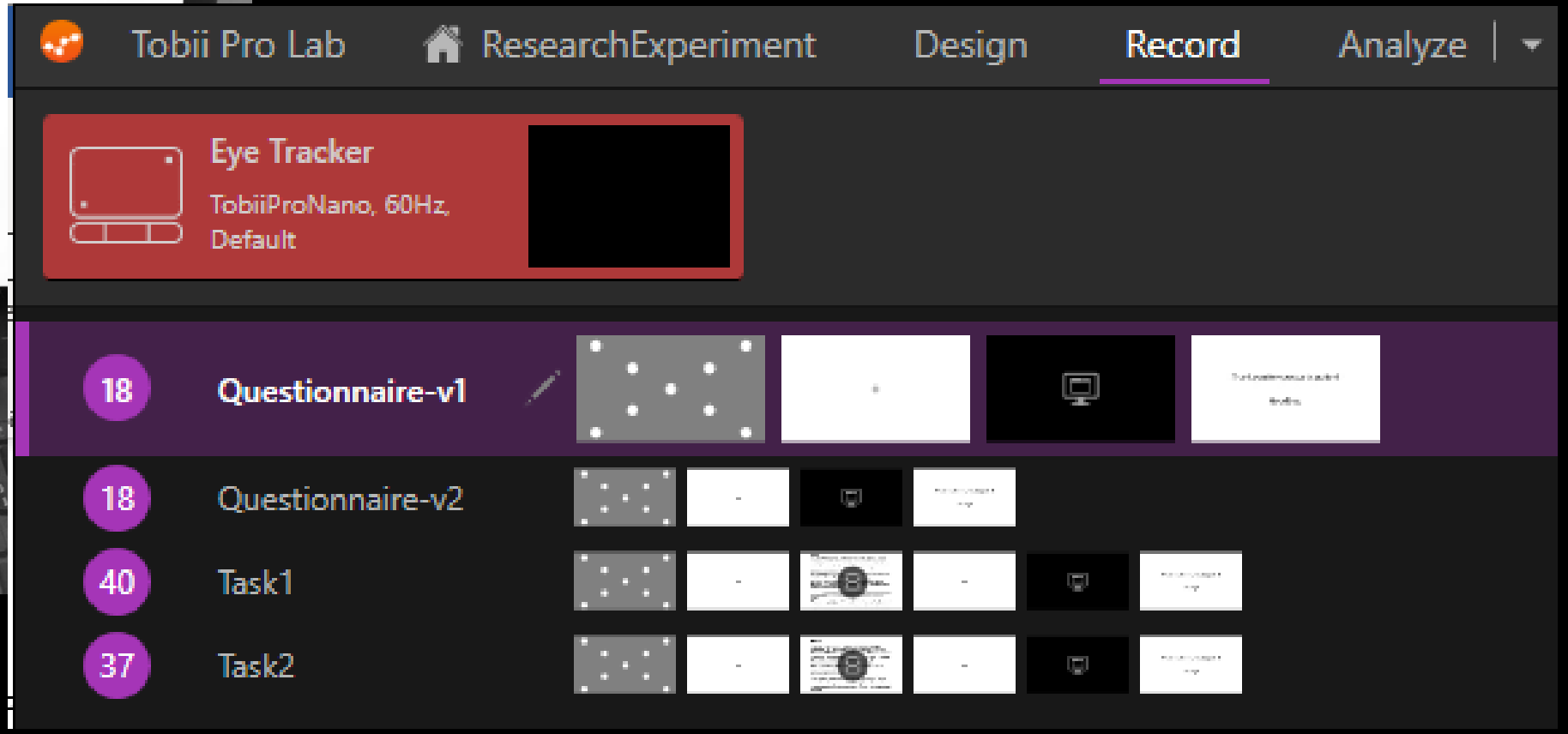
***Hypothesis 2: Attenuation Filter and Dictionary Units Hypothesis:*** experts are expected to make less fixations of shorter durations throughout each task in-comparison to non-experts.

***Hypothesis 3: Long-term Working Memory Hypothesis:*** experts are expected to retrieve relevant information from working memory more rapidly than non-experts, therefore, experts will have shorter fixation durations and shorter dwell times in comparison to non-experts, while making fewer errors than non-experts.

# EXPERIMENT DESIGN




- Tobii Pro Nano Eye Tracker
- Tobii Pro Lab Software
- FortiGate-90D Firewall

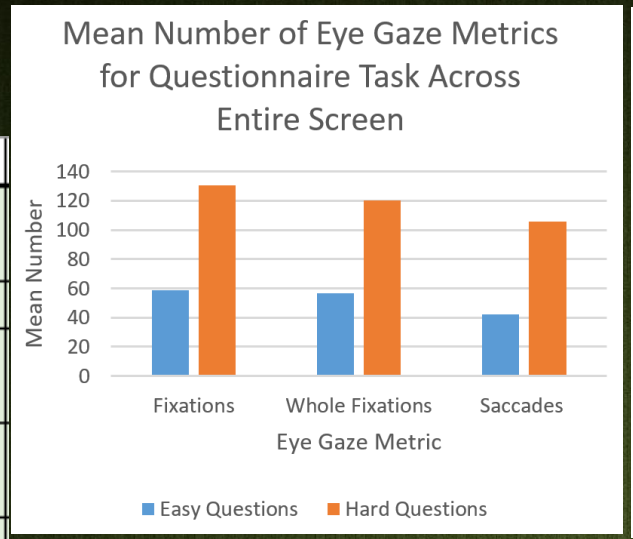


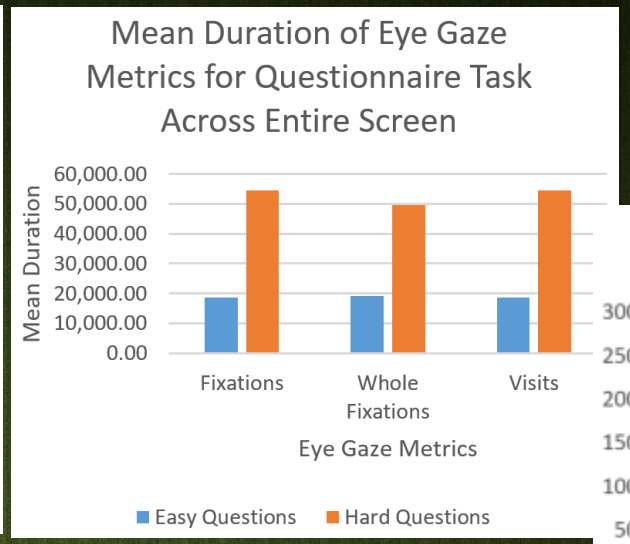
# FINDINGS FOR EACH TASK

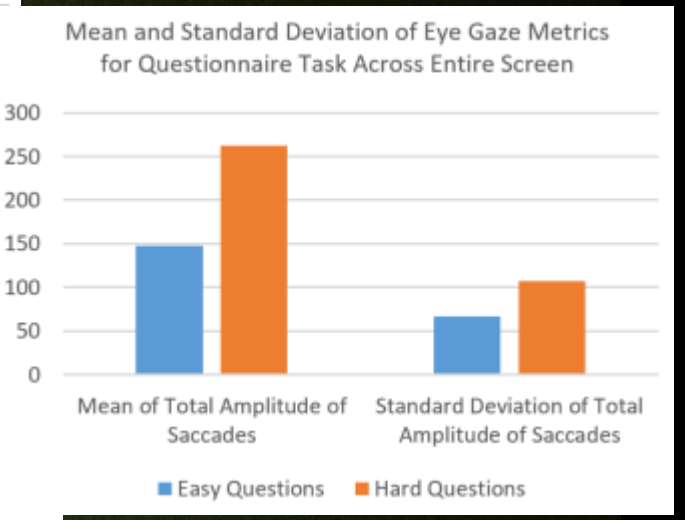
## ENTIRE SCREEN AOI

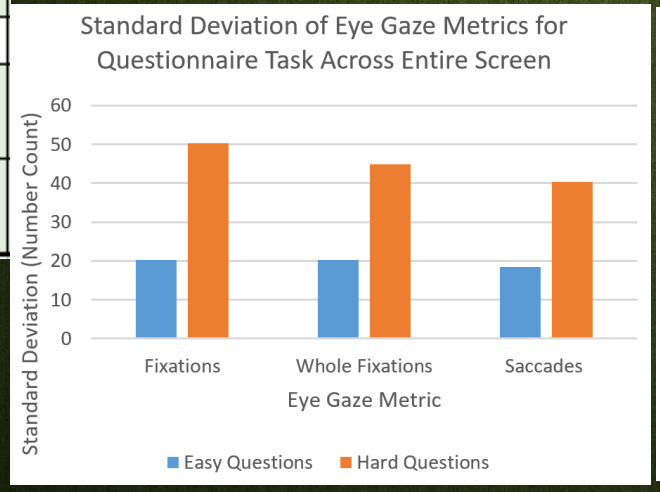
# RESULTS FOR QUESTIONNAIRE TASK

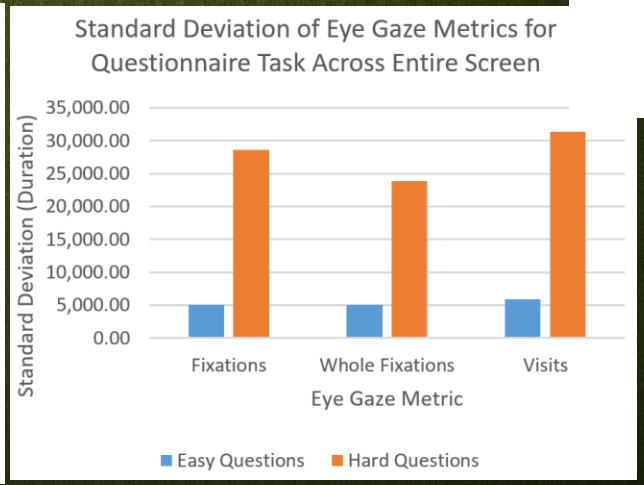
| T-test | Entire Screen AOI |
|---|---|
| Total Duration of Fixations | 2.77E-07 |
| Number of Fixations | 2.02E-08 |
| Total Duration of Whole Fixations | 1.20E-07 |
| Number of Whole Fixations | 1.62E-08 |
| Total Duration of Visits | 6.64E-08 |
| Number of Visits | N/A |
| Number of Saccades (AOI) | 8.93E-08 |
| Total Amplitude of Saccades (TOI) | 1.36708E-05 |



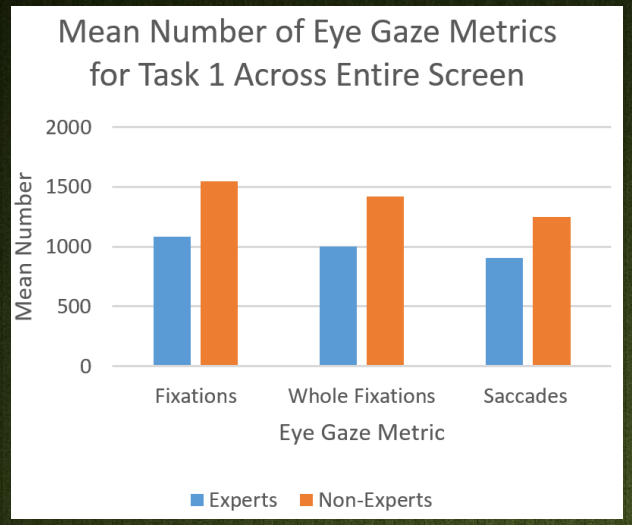



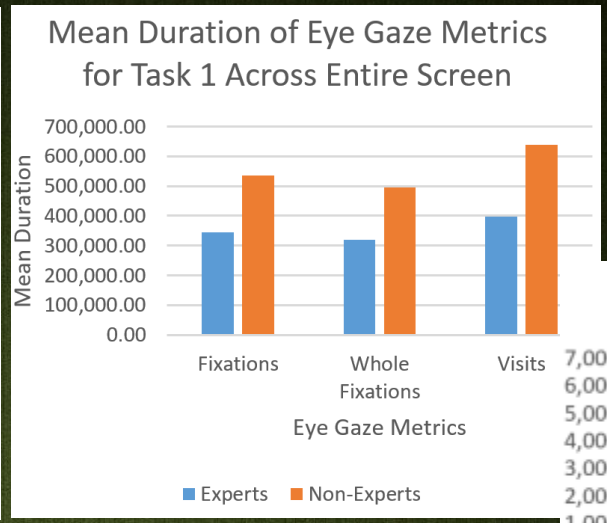



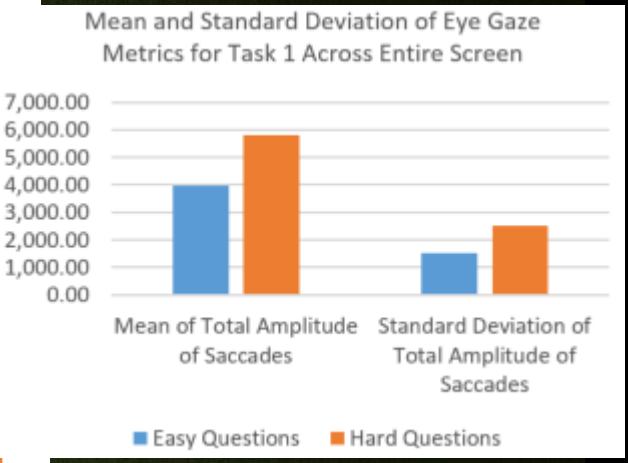
# RESULTS FOR NETWORK CONFIGURATION TASK 1

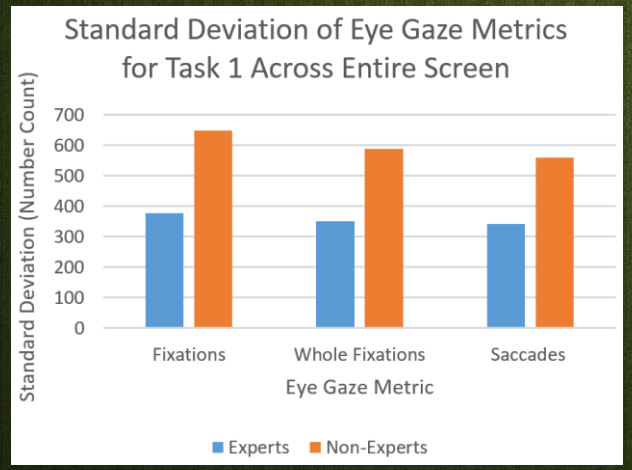
| T-test | Entire Screen AOI |
|---|---|
| Total Duration of Fixations | 0.02313056 |
| Number of Fixations | 0.045000478 |
| Total Duration of Whole Fixations | 0.022723908 |
| Number of Whole Fixations | 0.048403096 |
| Total Duration of Visits | 0.018924052 |
| Number of Visits | N/A |
| Number of Saccades (AOI) | 0.083679725 |
| Total Amplitude of Saccades (TOI) | 0.040636117 |

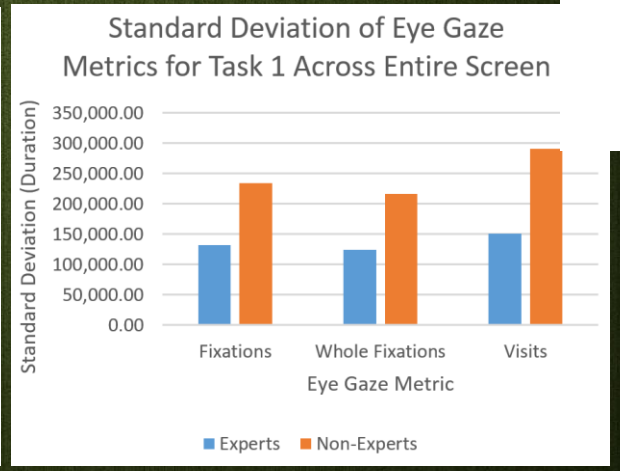
**Common error:** 9 non-experts failed to block the attacker from their network



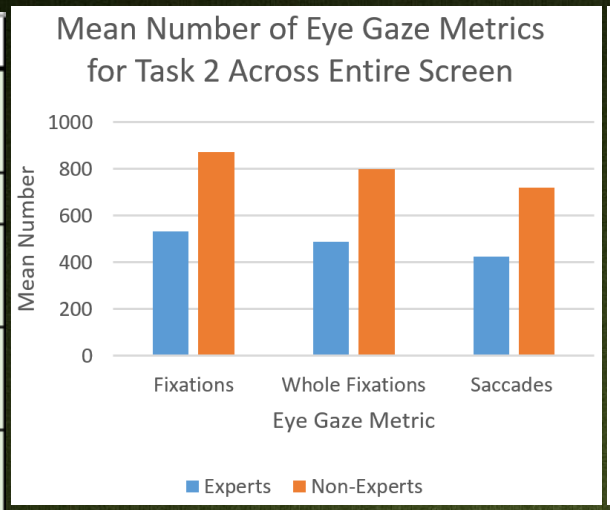



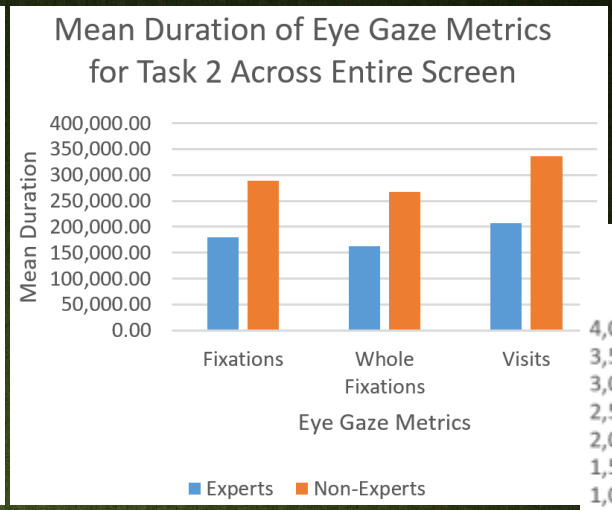



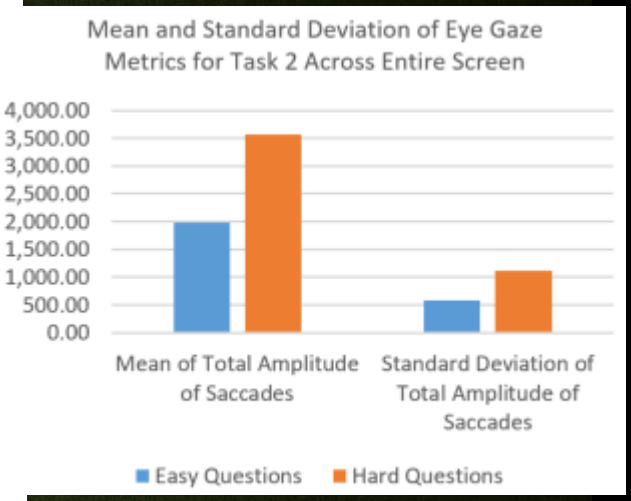
# RESULTS FOR NETWORK CONFIGURATION TASK 2

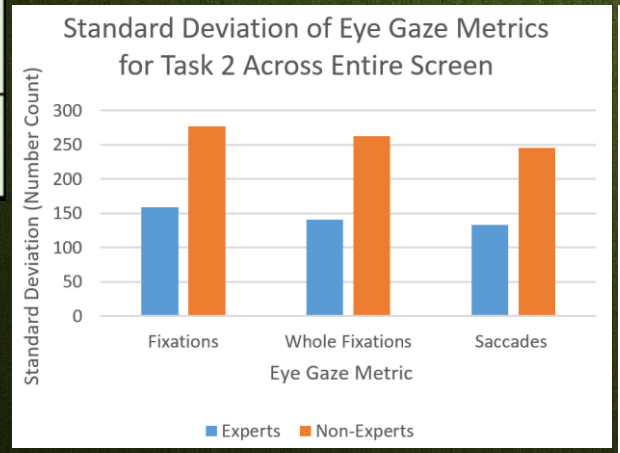
| T-test | Entire Screen AOI |
|---|---|
| Total Duration of Fixations | 0.011788231 |
| Number of Fixations | 0.004657775 |
| Total Duration of Whole Fixations | 0.012749469 |
| Number of Whole Fixations | 0.005318629 |
| Total Duration of Visits | 0.008319449 |
| Number of Visits | N/A |
| Number of Saccades (AOI) | 0.004679926 |
| Total Amplitude of Saccades (TOI) | 0.001306337 |

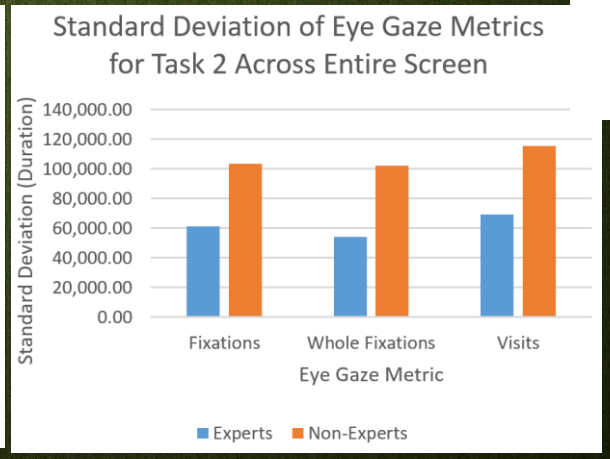
**Common error:** 8 non-experts failed to enable successful access for the contractor, of which 4 non-experts didn't create the service



# HYPOTHESES

***Main Hypothesis:*** *Experts have different eye gaze behavior when compared to non-experts*

***Hypothesis 1: Spotlight theory on parafoveal vision:*** experts are expected to have less saccades in comparison to non-experts with a possibly higher amplitude of saccades

***Hypothesis 2: Attenuation Filter and Dictionary Units Hypothesis:*** experts are expected to make less fixations of shorter durations throughout each task in-comparison to non-experts

***Hypothesis 3: Long-term Working Memory Hypothesis:*** experts are expected to retrieve relevant information from working memory more rapidly than non-experts, therefore, experts will have shorter fixation durations and shorter dwell times in comparison to non-experts, while making fewer errors than non-experts.

# PROPOSED MODEL

**A classifier was created with all the successful eye gaze metrics**

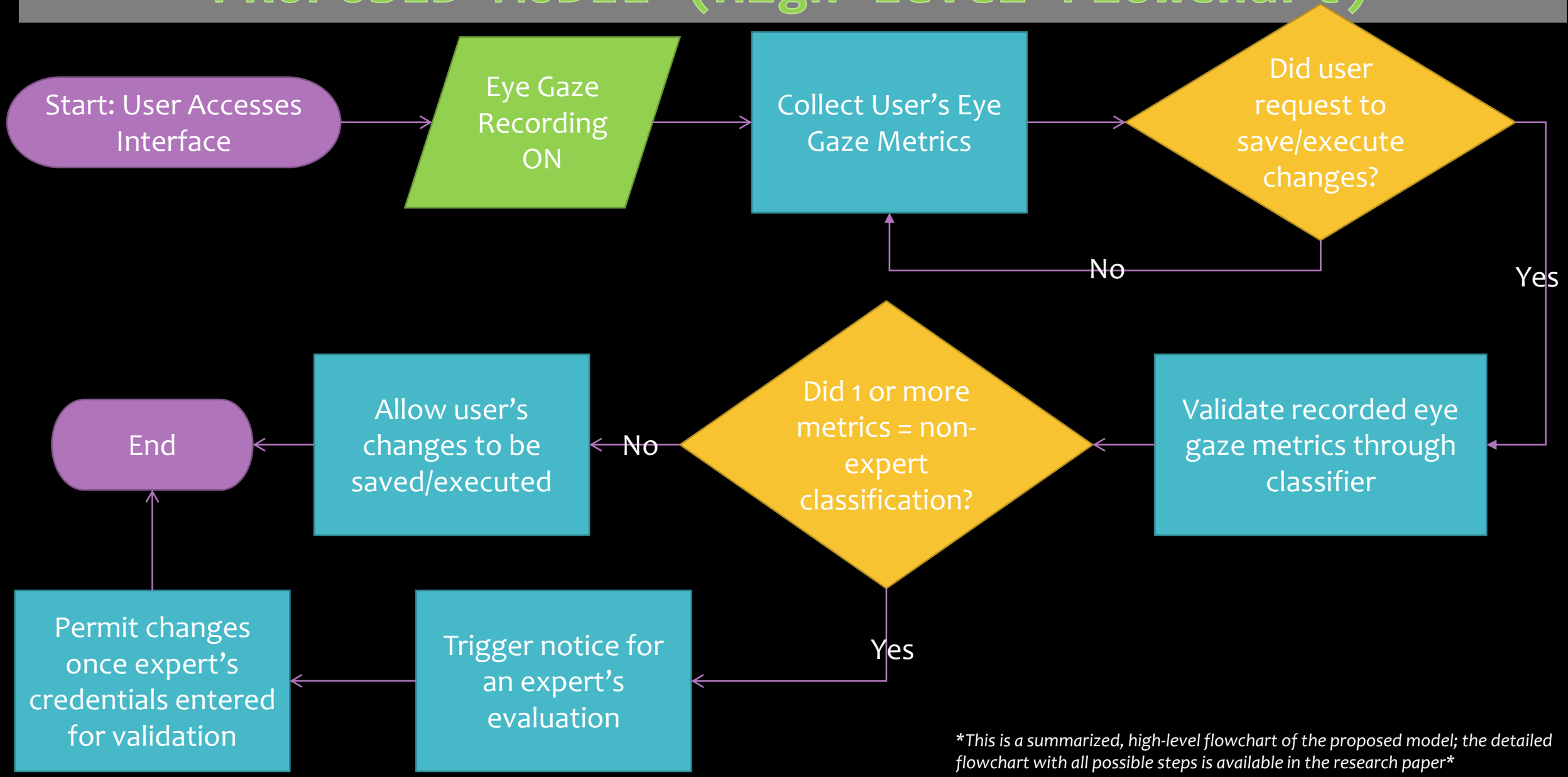
- **Classifies an expert with a "0" output and a non-expert with a "1" output**

- KStar: 99.74%
- Random Forest: 99.47%
- J48: 99.23%
- JRIP: 96.93%
- Decision Table: 92.60%
- Logistic: 88.77%

**An attribute selection method was executed using Wrapper Subset Evaluation for the best classifier**

- The search method (Best First) concluded that KStar had the best features, which were: Fixation Duration and Fixation Number, with KStart 99.74%

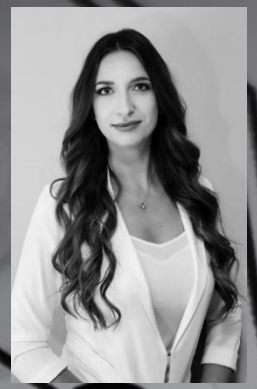
# PROPOSED MODEL (High Level Flowchart)



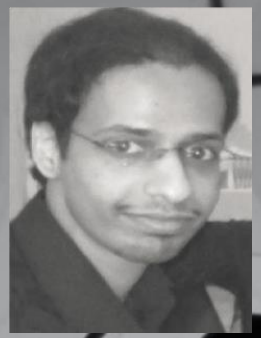

**This is a summarized, high-level flowchart of the proposed model; the detailed flowchart with all possible steps is available in the research paper**

# THANK-YOU FOR WATCHING!

# Eye Gaze-Based Human Error Prevention System: Experts vs. Non-Experts

**Oksana Kilik**
**oksana.kilik@ontariotechu.net**
Faculty of Business & Information Technology,
Ontario Tech University,
Ontario, Canada



**Dr. Abdulaziz Almehmadi**
**abdulaziz.almehmadi@ontariotechu.net**
Faculty of Computing & IT, SNCS Research Center,
University of Tabuk,
Tabuk, Saudi Arabia

**Dr. Khalil El-Khatib**
**Khalil.el-khatib@ontariotechu.net**
Faculty of Business & Information Technology,
Ontario Tech University,
Ontario, Canada