



أكاديمية طويق
TUWAIQ ACADEMY



SDAIA
الهيئة السعودية للبيانات
والذكاء الاصطناعي
Saudi Data & AI Authority

TUWAF | طاف

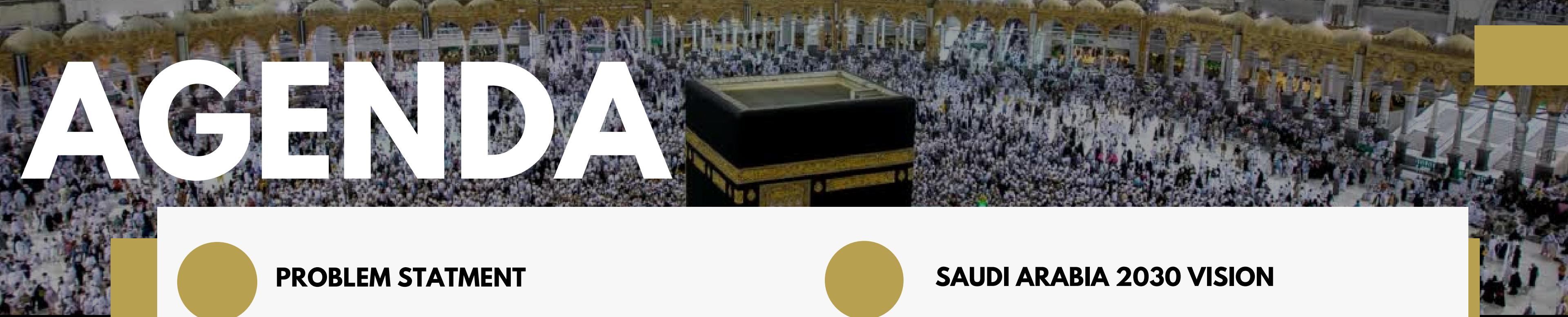
Autonomous Pilgrims Wheelchair

Data Science and Artificial Intelligence T5
Bootcamp

- Rama almarzuqi
- Esraa Abdullah
- Anas Almana
- Shoug Alkhalf
- Ali Aljumah



AGENDA

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- PROBLEM STATEMENT**
 - SAUDI ARABIA 2030 VISION**
 - TWWAF COMPONENTS**
 - DATA COLLECTIONS**
 - AUTONOMOUS DL MODEL**
 - TRANSFER LEARNING**
 - OBJECT DETECTION MODEL**
 - CHALLENGES DURING THE TRAINING PHASE**
 - APPLICATION IN REAL LIFE**
 - FUTURE WORK**
 - LIBRARIES ,TOOLS AND HARDWARE**
 - DEMO**

PROBLEM STATEMENT

- Elderly and special needs individuals need navigation support during Hajj or Umrah.
- Current solutions: manual wheelchairs operated by helpers, and electronic wheelchairs.

Challenges:

- Manual wheelchair demands human resources.
- Varied skills increase congestion and risks.

Our solution:

Twwaf is an AI-based autonomous wheelchair designed to enhance the experience, safety, and capacity in Hajj & Umrah.





SAUDI ARABIA 2030 VISION

Vision 2030 for Hajj and Umrah:

- Accommodate 30 million pilgrims.
- Deliver high-quality services to Hajj and Umrah pilgrims.
- Facilitate hosting and ease access to Holy Mosques.
- Enrich the religious and cultural experience.

Vision 2030 in Artificial Intelligence:

- Attaining leadership in AI-driven economies, elevating the Kingdom's status.





SAUDI ARABIA 2030 VISION

”مَوْهَنًا أَنْ نَبِيٌّ وَطَنًا أَكْثَرًا إِذْهَارًا؛ بِجَدٍ
فِيهِ كُلُّ مُوَاطِنٍ مَا يَئْمَنُهُ“

محمد بن سلمان بن عبد العزيز

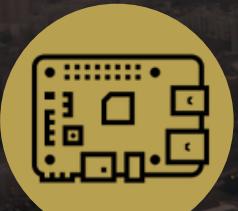


TWWAF COMPONENTS:

HARDWARE COMPONENTS



DC Motors



Microcontroller (Raspberry Pi)



Camera



Microphone



Power source

AI COMPONENTS



Autonomous Deep Learning Model



Object Detection Model (Navigation)



Voice Recognition Model (Voice Controller)

DATA COLLECTION

FOR AUTONOMOUS DRIVING

Images and controller values are collected as input-output pairs

Dataset: 100,314 observations

Training: 80,252

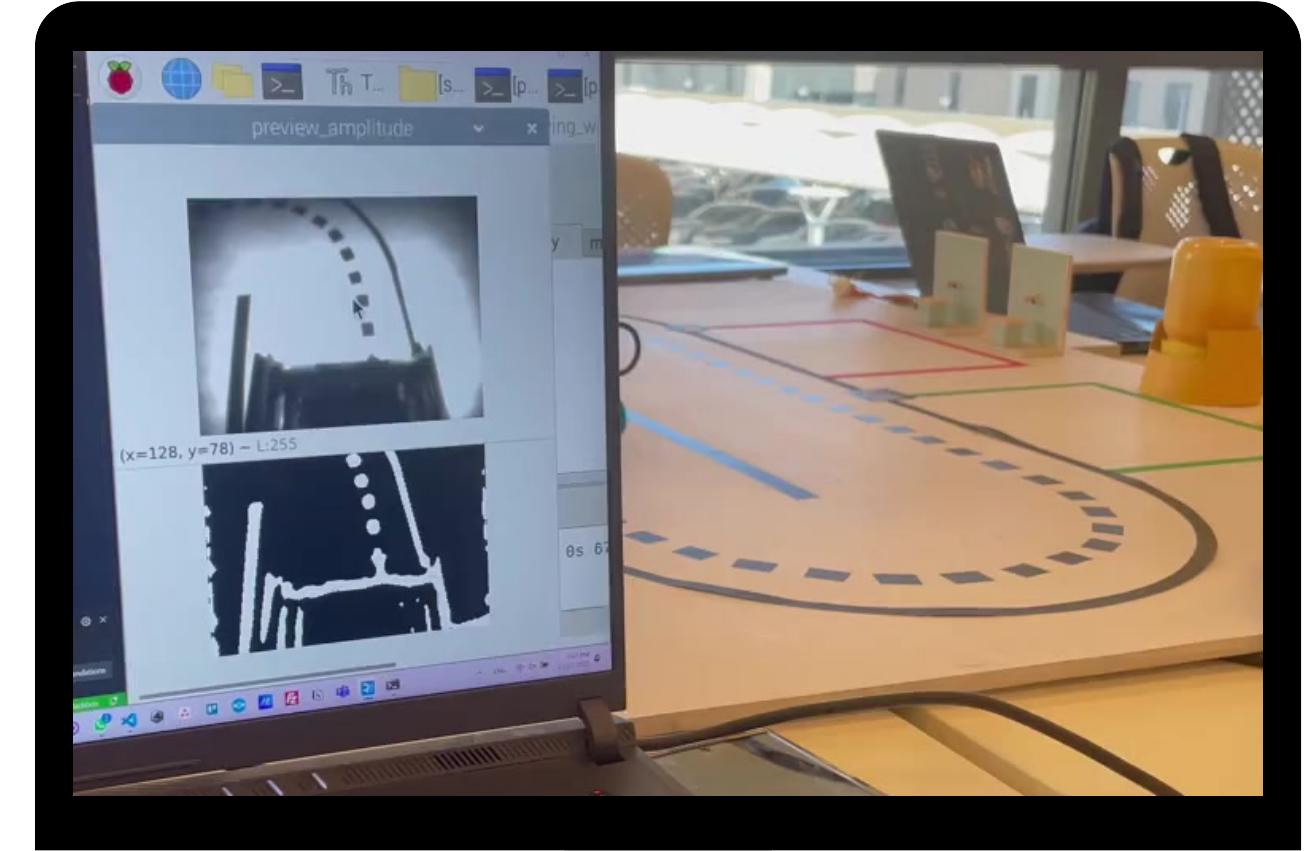
Validation: 20,062

Images: Grayscaled

Size: 240*180

Steering: (-1 to 1)

Throttle: (-1 to 1)



		img	steering	throttle
15496	IMG/Image_1700722675109781.jpg		-0.24787	-0.72652
15497	IMG/Image_1700722675143314.jpg		-0.24787	-0.72652
15498	IMG/Image_1700722675176277.jpg		-0.33335	-0.73507
15499	IMG/Image_1700722675209783.jpg		-0.33335	-0.73507
15500	IMG/Image_170072267524273.jpg		-0.27354	-0.73507
15501	IMG/Image_1700722675276112.jpg		-0.27354	-0.73507
15502	IMG/Image_1700722675310013.jpg		-0.18806	-0.73507
15503	IMG/Image_1700722675343279.jpg		-0.18806	-0.73507
15504	IMG/Image_1700722675376254.jpg		-0.18806	-0.73507

IMAGE LABELING DATA COLLECTION FOR OBJECT DETECTION MODEL

المواضئ



1,100 Images

ماء زمزم



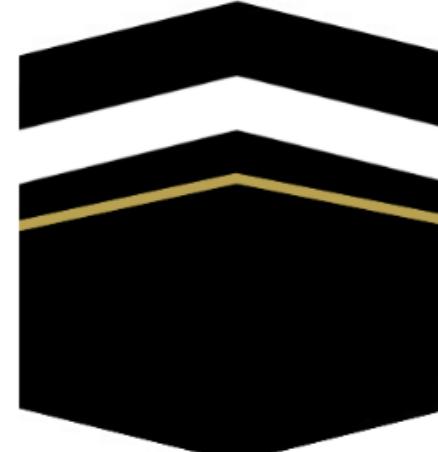
1,100 Images

الصفا والمروة



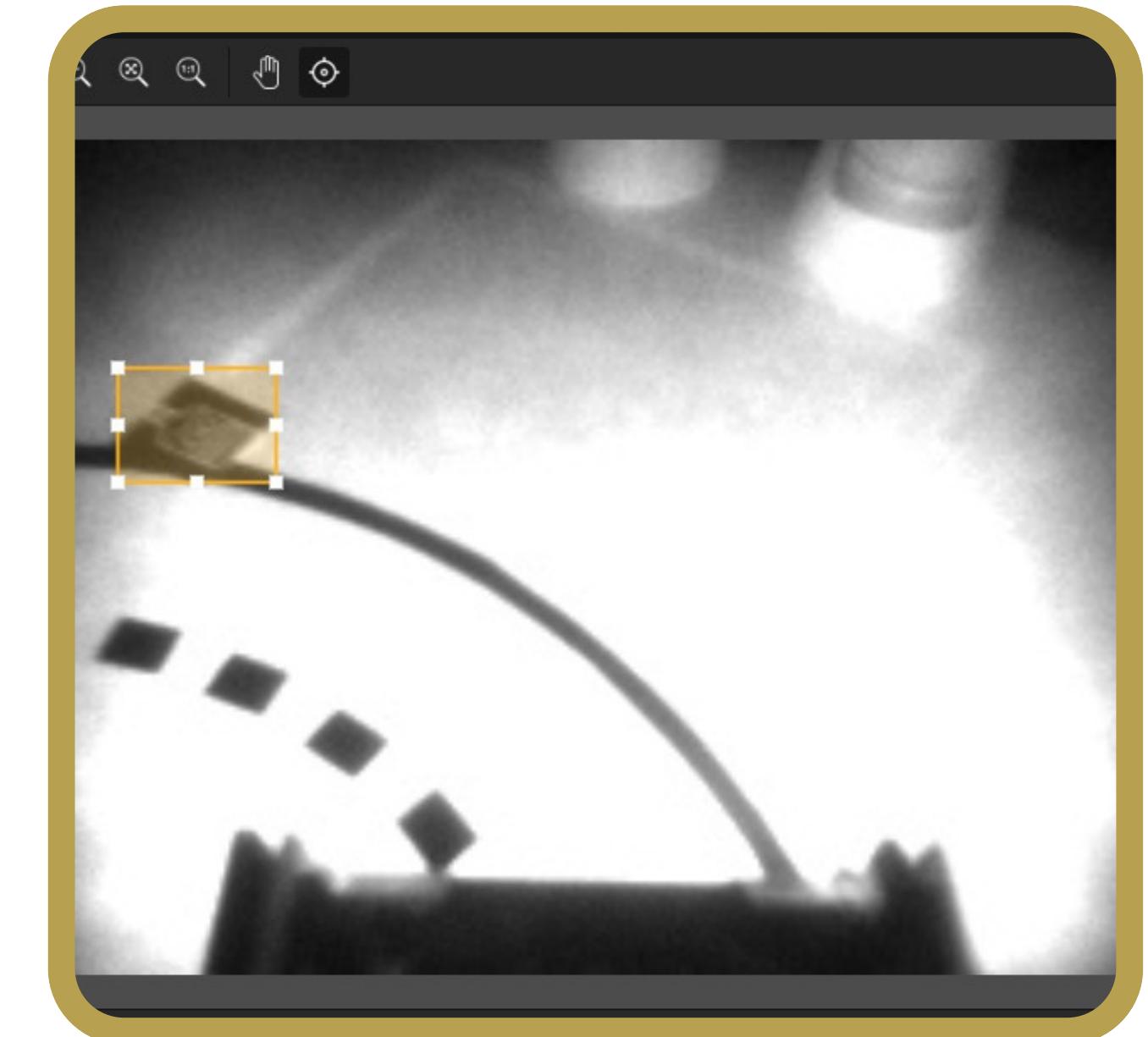
1,100 Images

المطاف



1,100 Images

4,400 images from various angles split on 80:20,
categorized into 4 distinct classes, and labeled manually.



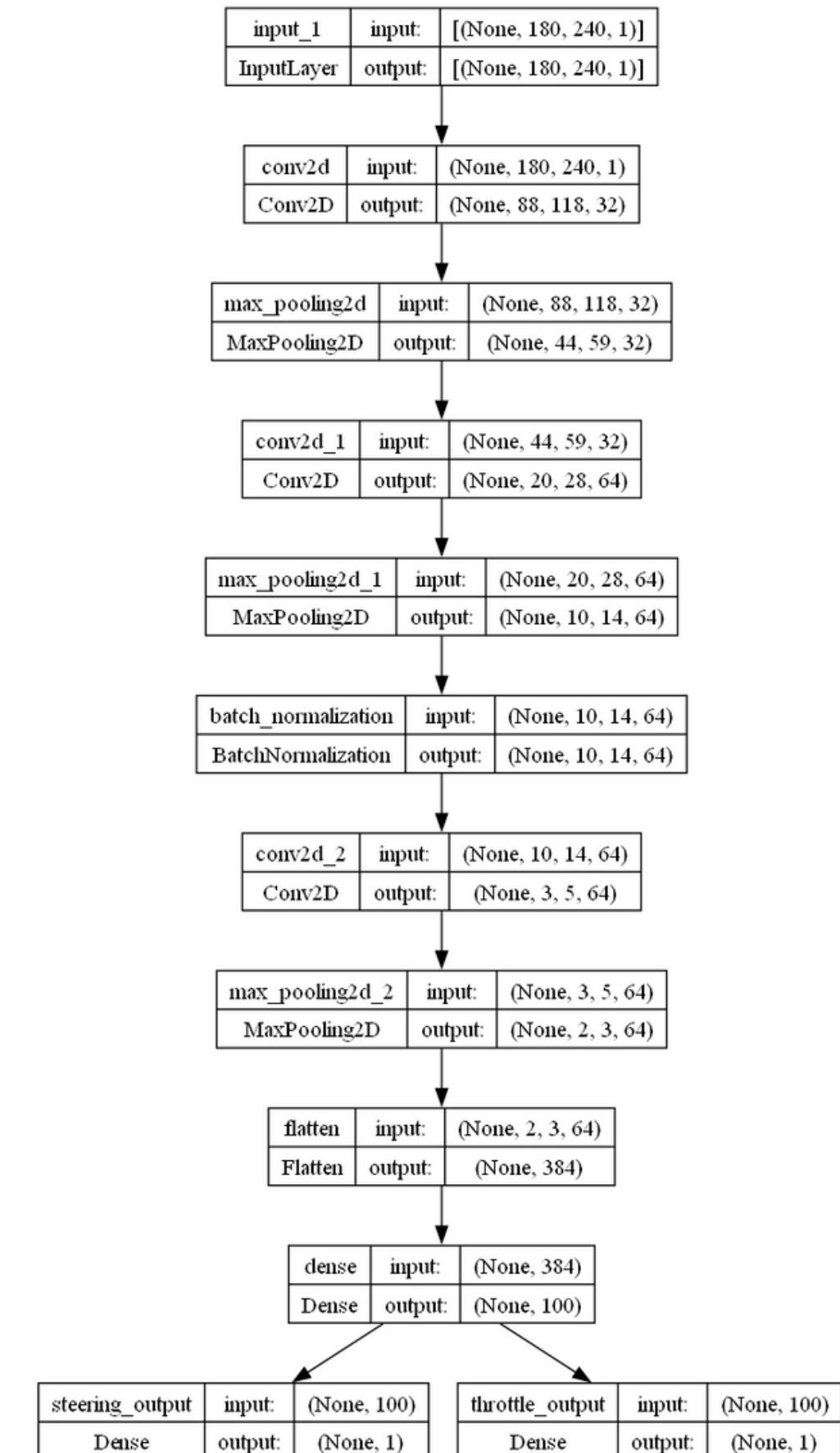
AUTONOMOUS WHEELCHAIR DL MODEL

- **Project methodology:** Behavioral cloning.
- **Behavioral Cloning:** Training ML models to mimic human behavior.
- **Origin:** Introduced by Nvidia.
- **Application:** Utilized in self-driving cars and robots.
- **Implementation:** Collecting input-output pairs from an expert demonstration (human in our case).



AUTONOMOUS WHEELCHAIR DL MODEL

- CNN deep learning model
- Consists of 11 layers with two heads (Steering & Throttle).
- Parameter: 193,518.
- Trained on previous dataset to clone the behavior of human driver.
- Successfully attained a Mean Squared Error (MSE) of 0.02.



MODEL

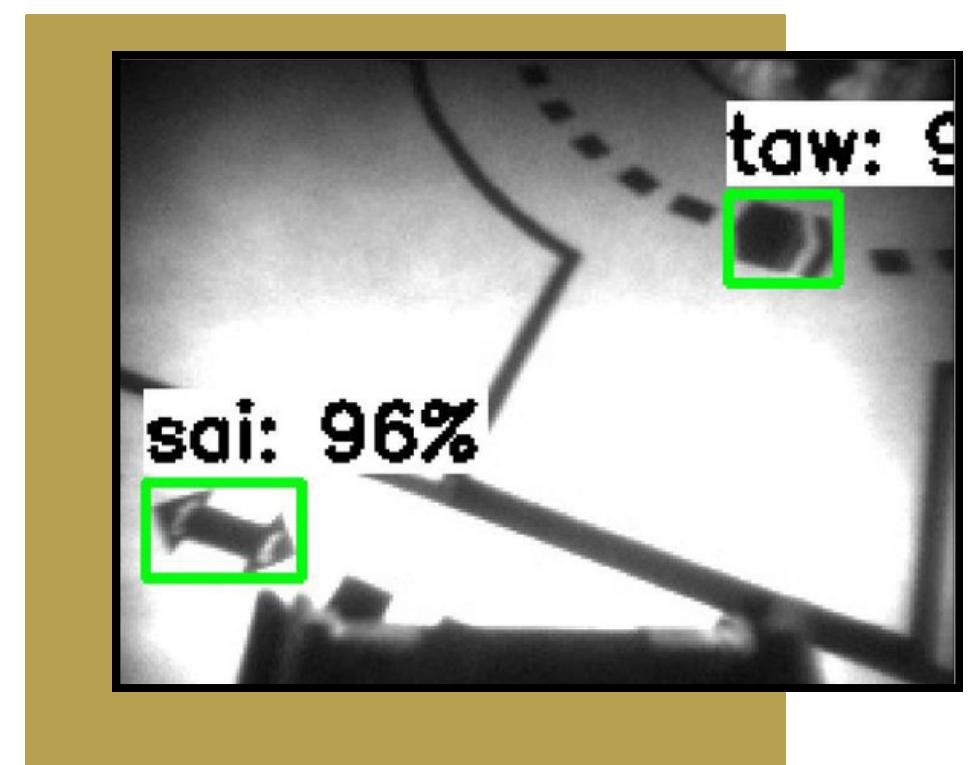
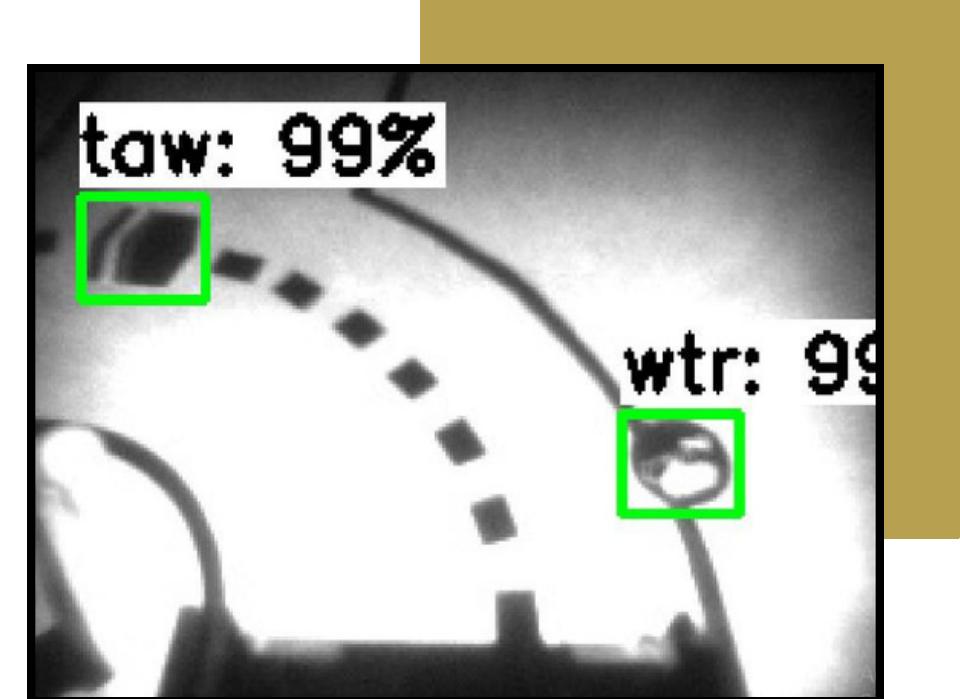
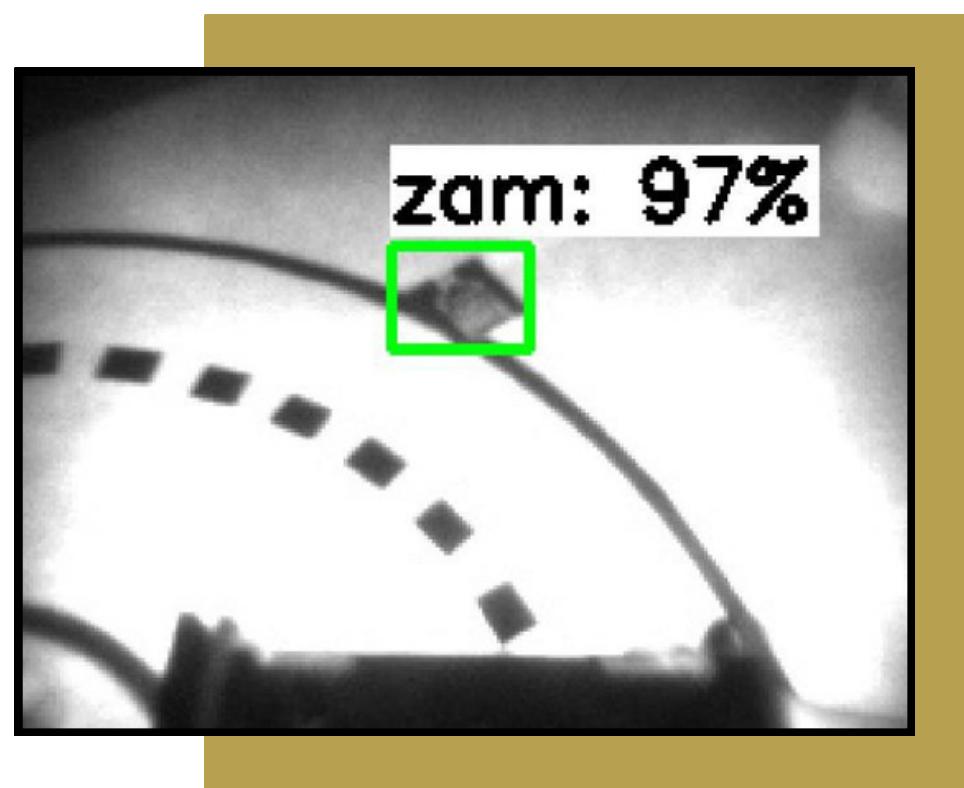
TRANSFER LEARNING

- Applied transfer learning for autonomous driving using **MobileNetV2**.
- Layers: 53
- Parameters: 2,430,338
- Achieved an MSE of 0.14
- MobileNetV2 deemed suitable but not utilized due to performance demands.
- First model was selected due to its lightweight and fast performance.

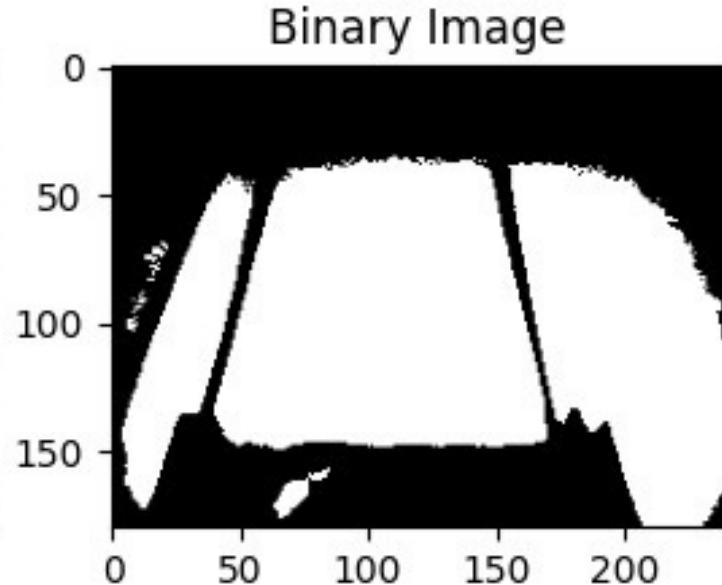
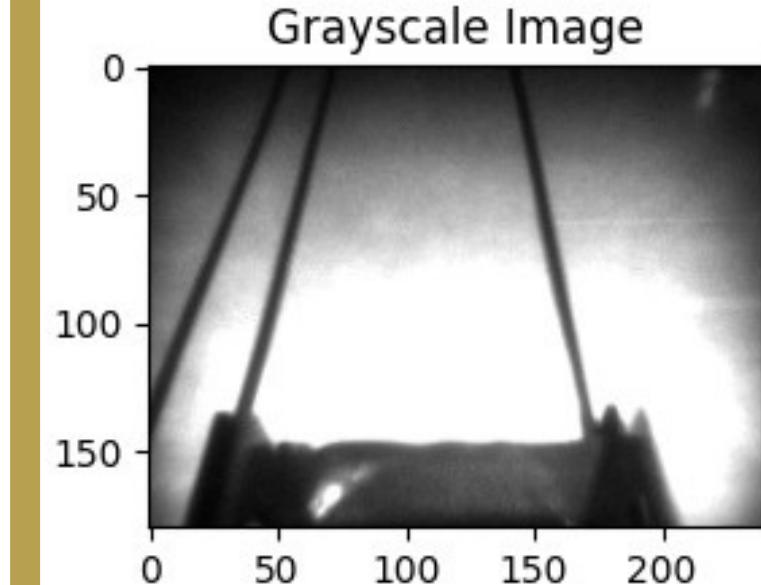
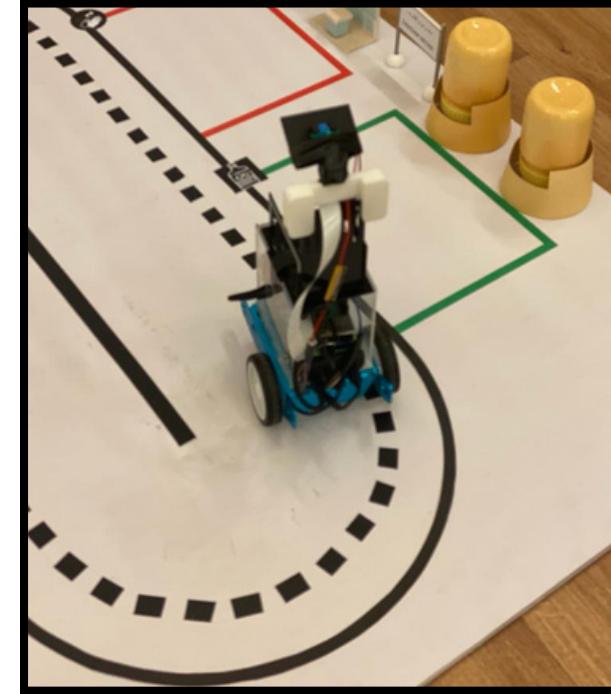
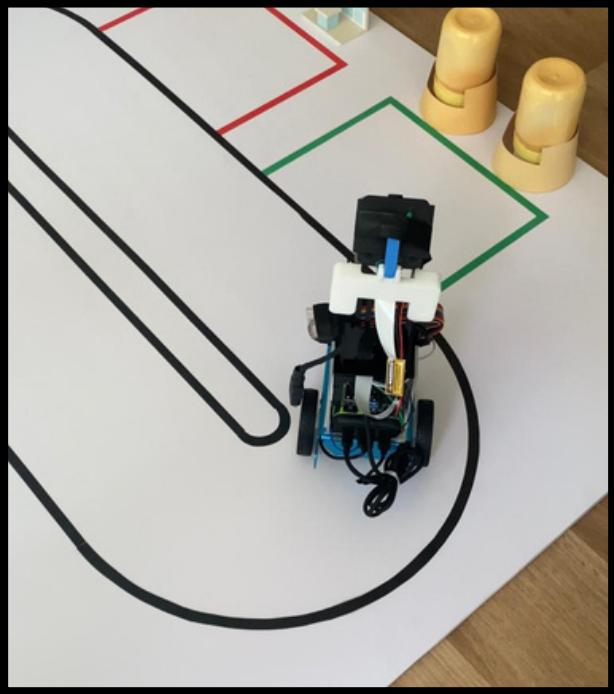
Type	Filter Shape	Input Size
Conv1	$3 \times 3 \times 3 \times 32$	$224 \times 224 \times 3$
Conv2 dw	$3 \times 3 \times 32$ dw	$112 \times 112 \times 32$
Conv2 pw	$1 \times 1 \times 32 \times 64$	$112 \times 112 \times 32$
Conv3 dw	$3 \times 3 \times 64$ dw	$112 \times 112 \times 64$
Conv3 pw	$1 \times 1 \times 64 \times 128$	$56 \times 56 \times 64$
Conv4 dw	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv4 pw	$1 \times 1 \times 128 \times 128$	$56 \times 56 \times 128$
Conv5 dw	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv5 pw	$1 \times 1 \times 128 \times 256$	$28 \times 28 \times 128$
Conv6 dw	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv6 pw	$1 \times 1 \times 256 \times 256$	$28 \times 28 \times 256$
Conv7 dw	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv7 pw	$1 \times 1 \times 256 \times 512$	$14 \times 14 \times 256$
Conv8 dw	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv8 pw	$1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$
Conv9 dw	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv9 pw	$1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$
Conv10 dw	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv10 pw	$1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$
Conv11 dw	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv11 pw	$1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$
Conv12 dw	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv12 pw	$1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$
Conv13 dw	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv13 pw	$1 \times 1 \times 512 \times 1024$	$7 \times 7 \times 512$
Conv14 dw	$3 \times 3 \times 1024$ dw	$7 \times 7 \times 1024$
Conv14 pw	$1 \times 1 \times 1024 \times 1024$	$7 \times 7 \times 1024$
Avg Pool	Pool 7×7	$7 \times 7 \times 1024$
FC	1024×25	$1 \times 1 \times 1024$
Softmax	Classifier	$1 \times 1 \times 25$

OBJECT DETECTION MODEL

- We employed a pre-trained Mobilenet-V2
- Data Summary:
 - Total Images: 4,400
 - Trainning Images: 3,520
 - Validation Images: 440
 - Tested Images: 440
- mAP Calculation Result:
 - Achieved a mean Average Precision of 74.36%.



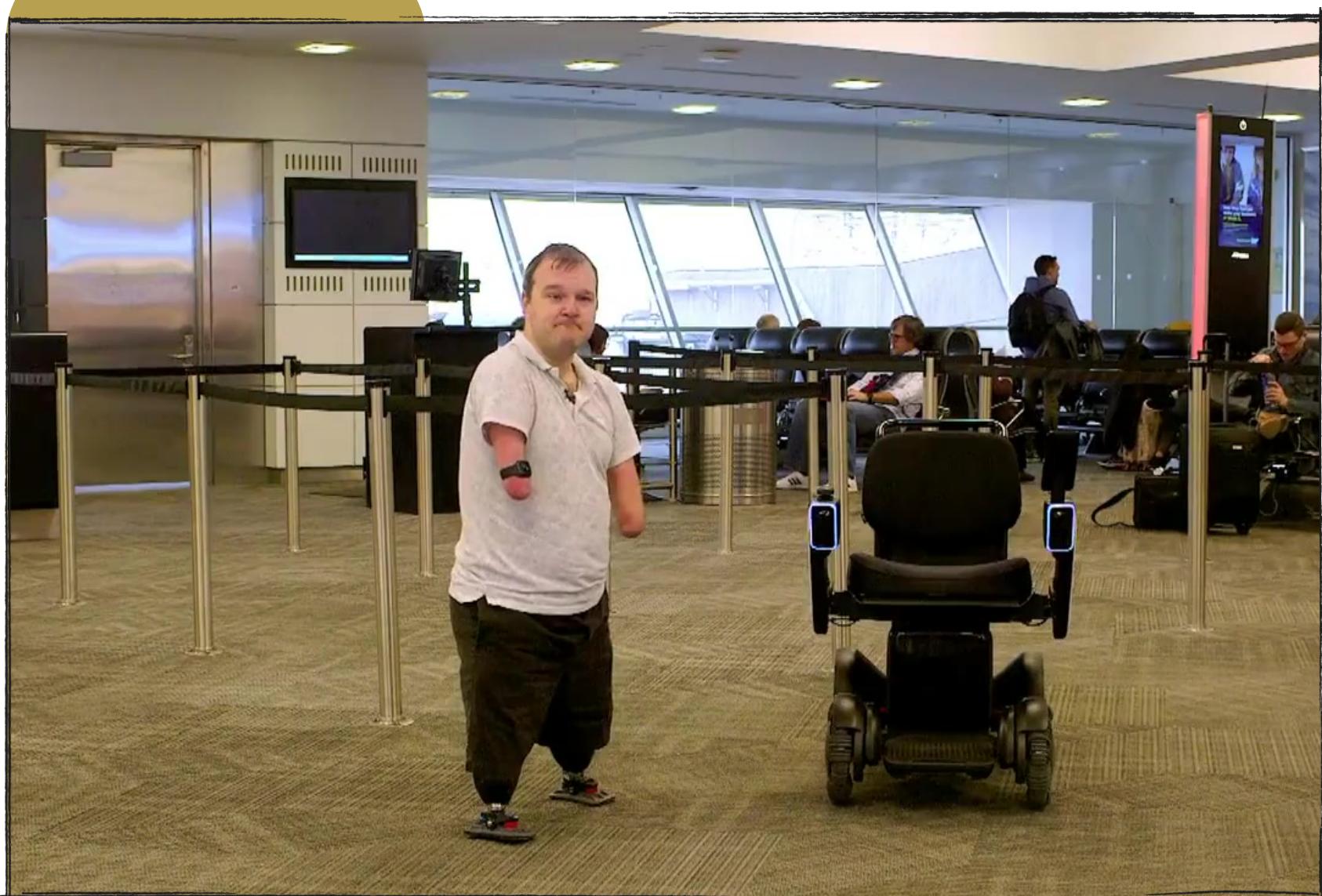
CHALLENGES ENCOUNTERED DURING THE TRAINING PHASE



- **Challenge:** Difficulties in recognizing the track
- **Solution:** Addressed by incorporating additional patterns to augment the features

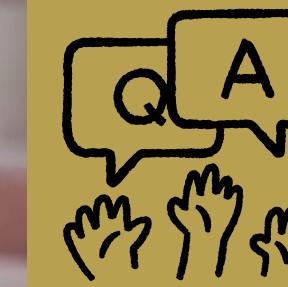
- **Challenge:** Imaging device quality
- **Solution:** Solved by applying image processing

APPLICATION IN REAL LIFE



Wheelchairs get the Tesla treatment with new smart tech

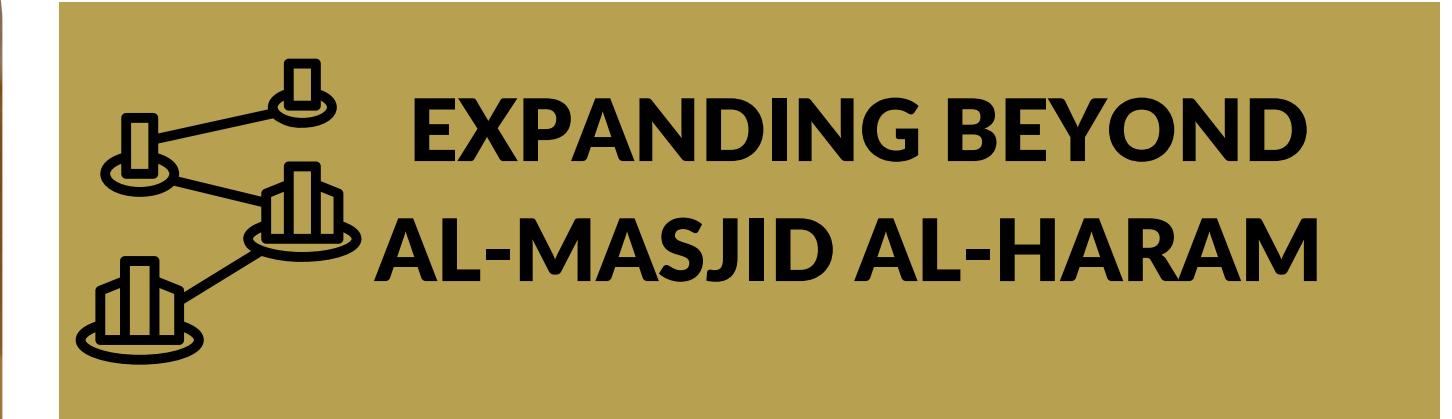
ABOUT OUR FUTURE WORK



NLP FOR Q&A
(FATWA AND UTILITY MAP)

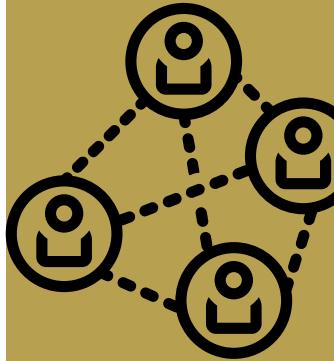


LANGUAGE
INCLUSIVITY



EXPANDING BEYOND
AL-MASJID AL-HARAM

ABOUT OUR FUTURE WORK

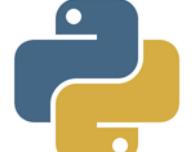


INTERCONNECTED
TWWAF'S



ANTI-COLLISION
SYSTEM

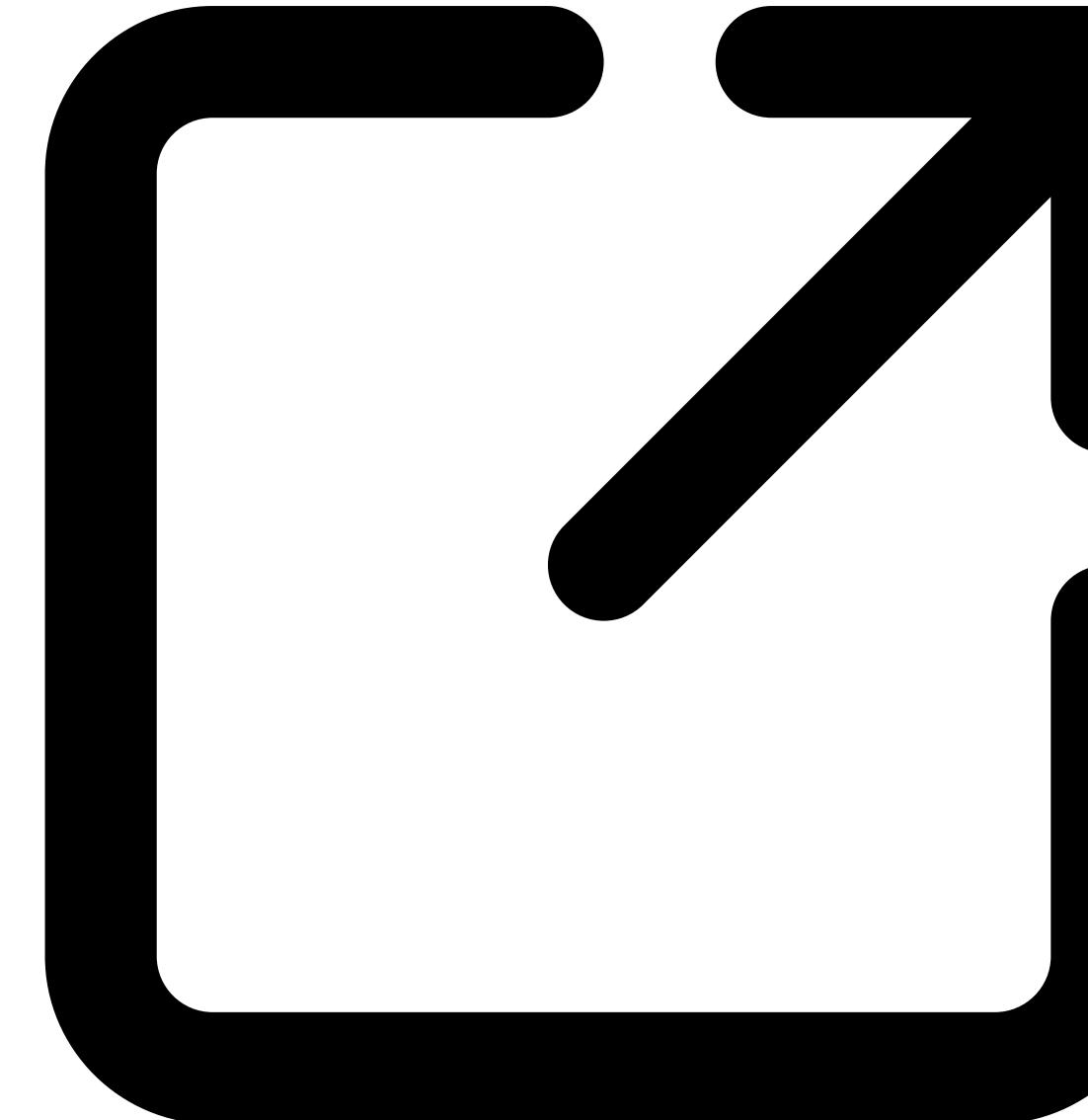
LIBRARIES ,TOOLS AND HARDWARE

Pre-Processing and Visualization	 pandas	 NumPy	 matplotlib	 python
Build Model	 Keras	 TensorFlow		 OpenCV
Environment		 Visual Studio Code	 Thonny	

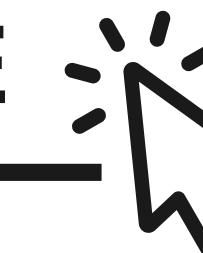
TWWAF TEAM :



SCAN HERE



CLICK HERE



The screenshot shows a dark-themed mobile application interface. At the top is a circular profile picture with the Arabic word "طَوَاف" (Tawaf) and a small gold-colored geometric logo. Below it, the text "TWWAF | طَوَاف" and "Autonomous Pilgrims Wheelchair" is displayed. A section titled "TWWAF GITHUB" shows a GitHub icon and the text "Github". The main content area is titled "TWWAF Team Members" and lists five team members with their profile pictures, names, and handles:

- Rama Almarzuqi | راما المرزوقي | @RamaAlmarzuqi
- Shoug Alkhalf | شوق الخلف | @ShougAlkhalf
- Esraa Abdullah | إسراء عبدالله | @esraa_abdullah
- Anas Almana | آنس آل مانع | @anasalmana
- Ali Aljumah | علي آل جمعة | @ali.aljumah

DEMO

