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TYRZ AI – AI-Powered Tyre Health Scanner Using Computer Vision

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ABSTRACT :

Tyre tread depth is a safety-critical quantity that most drivers check only by eye, and measuring it normally needs a depth gauge. This paper describes TYRZ AI Tyre Health Scanner, a web prototype that asks a user to photograph a tyre tread with a reference object of known size in the frame, and then presents a tread-depth value, a condition label and an estimate of remaining tyre life in a health report. The prototype is hosted as a login-protected web portal, branded "TYRZ // AI Telemetry", with pages for scanning, a health report, a vehicle record and a description of the AI. The paper documents what could be observed from the deployed interface and two screenshots, namely the account workflow, the guided photo-capture page and the calibration instructions, and states what could not be observed: the image-analysis method, the model, the accuracy of the reported depth and the basis of the remaining-life figure. No measurement accuracy, latency or user-study results are reported. TYRZ AI supports inspection decisions only and does not replace a physical tread-depth measurement or a professional tyre inspection.

Keywords: tyre health; tread depth; computer vision; reference-object calibration; vehicle safety; web application; decision support

Introduction

Worn tyres lengthen braking distances, especially on wet roads, and many countries set a legal minimum tread depth; 1.6 mm is the limit in the United Kingdom and in much of Europe. In practice a driver judges wear by looking at the tyre, and an objective reading needs a tread-depth gauge, a tool most owners do not carry. A camera-based check is attractive because almost every driver owns a smartphone.

TYRZ AI Tyre Health Scanner is a college project that offers such a check as a web application. The user logs in, photographs the tyre tread beside a coin or card, and receives a report. This paper documents what the prototype presents to the user, states what has and has not been verified, and identifies the limits that follow. The contribution is a description of one working interface and its workflow; it is not a new measurement algorithm, and no claim of measurement accuracy is made.

Problem Statement and Objectives

Tread depth is easy to neglect and hard to measure without a tool, and a single photograph taken carelessly gives unreliable numbers. The project objectives are to let a user capture or upload a tread photograph from a phone or computer; to guide the user towards a usable photograph through a calibration cue and photo guidelines; to report tread depth, a condition label and an estimate of remaining life; to keep reports and vehicle details per user account; and to state the limits of an image-based estimate. These are design objectives; Section 5 separates what was observed from what remains unverified.

Related Work

Recovering metric size from a photograph requires a scale. A common approach is to place an object of known size in the scene, so that millimetres per pixel can be computed in the plane of that object; camera calibration more generally is treated by Zhang (2000), and the geometry of recovering

structure from one or several views is set out by Hartley and Zisserman (2003). The TYRZ interface asks for a coin of about 19–25 mm or a card, which is the same idea in its simplest form.

Locating tyre features in an image is an object-detection or segmentation problem, for which real-time detectors such as YOLO (Redmon et al., 2016) are widely used. We have not been able to establish which, if any, of these methods TYRZ AI uses; they are cited as background only. We reviewed only these three sources, which do not amount to a systematic review, and we make no claim about the novelty of the system or about its relation to commercial tyre-scanning products.

System Design and Methodology

4.1 Architecture and access

TYRZ AI is a client–server web application served from a public hosting address (tyrz-telemetry-lab.onrender.com). A visitor first sees an intro screen showing a Ferrari F40 image and the text “Click anywhere to enter portal”, with a “Replay intro” control. The next screen is a login panel headed “TYRZ // AI Telemetry” with a “Server online” indicator and two tabs, Login and Create Account. Login asks for a username and password; account creation asks for a username, e-mail address, password and password confirmation. After login the navigation bar shows five entries (Home, Scan Tyre, Health Report, My Vehicle, About AI), the logged-in user as “Pilot: <username>” and a Logout button. The home page offers two actions, “Scan My Tyre” and “Telemetry Portal”. Table 1 lists the components that could be confirmed.

Table 1 - Components confirmed from the deployed interface

Component	Confirmed detail
Delivery	Public web portal hosted on onrender.com; page title “Ferrari F40 – Tyre Performance & Telemetry Portal”
Accounts	Create-account and login forms (username, e-mail, password); per-user greeting and Logout
Pages	Home, Scan Tyre, Health Report, My Vehicle, About AI, Telemetry Portal
Capture	Camera capture or file upload; Retake Photo control; calibration cue and photo guidelines
Output (as presented)	Tread depth in mm, condition label, estimated remaining distance in km
Front-end / back-end stack, analysis method, database	Not inspected for this paper; authors to add

4.2 Capture workflow

The home page summarises the workflow in three steps: Take Photo (“capture tread pattern”), AI Analysis (“compute 3D wear profile”) and Health Report (“get tread depth and life”). The Scan Tyre page, titled “Upload Tyre Photo & Use Camera”, lets the user take a photograph with the device camera or upload an existing image. Once an image is loaded it appears in a preview panel with a Retake Photo button. The page prints the following guidance (Table 2) and shows a pair of example photographs, one marked as a good photo with a reference object and one marked as blurry or far away.

Table 2 - Photo requirements stated on the Scan Tyre page

Requirement	Purpose (our reading)
Place a reference object (coin of about 19–25 mm, or a card) flat in the camera plane	Gives a known length for millimetre scaling
Align the tyre grooves with the green optical guidance line	Fixes the orientation of the tread in the frame
Make sure the tread area is well lit	Keeps groove edges visible
Hold the camera straight and perpendicular to the tread	Limits perspective distortion
Include the full width of the tread pattern where possible	Allows all grooves to be assessed

4.3 Scale calibration principle

The interface describes a reference object “for millimetre scale calibration”. The standard way to use such an object is to measure its apparent diameter d in pixels, divide its true diameter D by it, and apply the resulting scale to other lengths measured in the same plane:

$$s = D / d, \quad (\text{mm per pixel}), \quad L_{\text{mm}} = s \cdot L_{\text{px}} \tag{1}$$

We present Eq. (1) as the principle that the calibration cue relies on, not as a verified description of the TYRZ code. Two consequences follow whichever implementation is used. First, Eq. (1) is valid only for lengths lying in the plane of the reference object, and a groove bottom lies below the tread surface. Second, a single photograph taken square-on shows groove width and spacing but not groove depth, so a depth in millimetres must be

inferred from appearance, from a learned model, or from a second view. The interface mentions a "3D wear profile"; how it is obtained from a single image has not been established.

4.4 Report outputs

The home page shows a summary card with a tread depth of 4.8 mm, a green condition marker labelled GOOD and an estimated 28,500 km remaining. This card sits on a stock image of a Ferrari F40 tyre and is not the result of a scan the authors show being made, so we treat it as an illustration of the report format. If the legal minimum is taken as 1.6 mm, a reading of 4.8 mm would leave 3.2 mm of usable tread, but the rule that converts depth into kilometres, and the thresholds that separate condition labels, are not documented in the material available to us.

4.5 Account and data handling

Reports and vehicle details are tied to a user account, which implies that photographs, tyre readings and vehicle information are stored per user. The password-storage method, session handling, retention of uploaded photographs and any privacy policy were not inspected and must be documented before real use.

Implementation Status and Observations

This section reports what was observed in the deployed interface. The screenshots in Figs. 1 and 2 were taken from the running portal while logged in. Two screens were captured: the post-login home page and the Scan Tyre page with a photograph loaded. No automated test suite, repeated trials, timing measurements, accuracy tests against a depth gauge or user studies were carried out, and the analysis step was not exercised in a way that could be reported.

Fig. 1 shows the product name, the navigation bar and the sample summary card. Fig. 2 shows that a user photograph can be loaded and previewed, with the calibration instructions on the same page. In the photograph shown in the preview no reference object is visible beside the tread, which is the situation the page warns about. The screenshots show that the interfaces exist; they do not show a completed analysis, a correct depth or a correct remaining-life estimate.

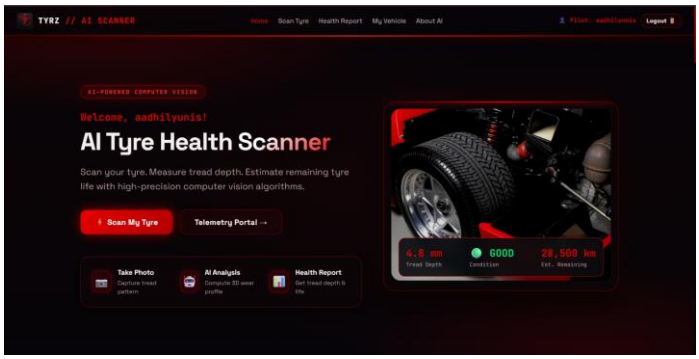


Fig. 1 - Home page of the TYRZ AI Tyre Health Scanner after login, with the three-step workflow and the sample summary card (prototype screenshot)

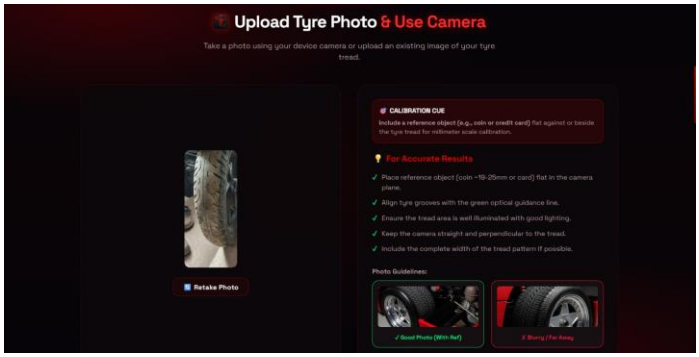


Fig. 2 - Scan Tyre page with an uploaded photograph, the calibration cue and the photo guidelines (prototype screenshot)

Table 3 - Implementation status of the main features

Feature	Evidence	Status
Account creation and login	Interface	Present; security properties not inspected
Camera capture / upload with preview	Screenshot, interface	Present
Calibration cue and photo guidelines	Screenshot	Present as on-screen guidance
Tread-depth measurement	Interface text only	Not verified; method and accuracy unknown
Condition label and remaining life	Home-page sample card	Format shown; derivation not documented
Health Report, My Vehicle, About AI pages	Navigation entries	Listed; contents not captured here

Discussion

The prototype shows that a guided photo-capture flow, per-user accounts and a report layout can be assembled in one web portal. It does not show that the reported depth is correct. The interface uses phrases such as “high-precision computer vision algorithms” and “3D wear profile”; until the method is documented and tested against gauge measurements, this paper treats them as descriptions of intent, and the displayed numbers as estimates. The calibration cue is a sensible design choice because it makes the scale explicit, but its benefit depends on the user actually following it. A reading labelled GOOD means only that the system placed the estimate in its best band; it is not a safety certificate.

Limitations and Threats to Validity

Method not documented. The image-analysis method, any trained model and its training data were not available for inspection; accuracy, bias across tyre types and failure modes are unknown.

Single-image geometry. A square-on photograph gives lateral scale in the reference plane, not groove depth. Perspective, lens distortion and a reference object not lying flat will each introduce error.

Capture conditions. Poor lighting, dirt in the grooves, shadows, worn or unusual tread patterns and partial views can change the result. The preview photograph in Fig. 2 shows a dirty tread seen at an angle.

Remaining-life estimate. Distance remaining depends on driving style, load, road, tyre compound, inflation and alignment, none of which a photograph captures. A single km figure should be read as a rough guide.

Evidence. Evidence is limited to the deployed interface and two screenshots; there is no accuracy test, independent evaluation or user study, and the literature review covers three sources.

Security and privacy. Authentication, storage of photographs and vehicle data, and the handling of personal information must be reviewed before any real use.

TYRZ AI provides decision support only and cannot replace a physical measurement or a professional inspection.

Future Scope

Planned work, not yet implemented unless the authors state otherwise, includes documenting and publishing the analysis pipeline; validating depth estimates against a calibrated depth gauge across tyre brands, sizes and wear states; reporting error statistics with confidence intervals; automatic detection of the reference object and of poor-quality photographs; a documented, evidence-based remaining-life model; support for pressure, age and damage indicators; multilingual support; privacy-conscious handling of photographs; and a user study.

Conclusion

TYRZ AI Tyre Health Scanner is a working web prototype that guides a user through photographing a tyre tread with a reference object and presents the outcome as a health report within a per-user portal. On the interface and screenshots inspected, the capture workflow and calibration guidance are present, while the measurement method, accuracy and remaining-life basis remain undocumented. No performance or effectiveness claim is made. Validation against physical measurements and a documented method are needed before the system is relied on for real maintenance decisions.

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