

# **MODEL DEVELOPMENT FOR PUSH UP COUNTING BY UTILIZING BODY LANDMARKS AND LSTM ALGORITHM**

## **SKRIPSI**



**PROGRAM STUDI ILMU KOMPUTER (S1)  
JURUSAN TEKNIK INFORMATIKA  
FAKULTAS TEKNIK DAN KEJURUAN  
UNIVERSITAS PENDIDIKAN GANESHA**



- UU ITE No. 11 Tahun 2008 Pasal 5 Ayat 1 "Informasi Elektronik dan/atau hasil cetaknya merupakan alat bukti hukum yang sah"
- Dokumen ini telah ditandatangani secara elektronik menggunakan sertifikat elektronik yang diterbitkan BSrE - BSSN, validitas dokumen elektronik ini bisa dicek menggunakan aplikasi mobile VeryDS oleh BSrE
- Cetak dokumen ini merupakan salinan dari file dokumen bertandatangan elektronik yang keabsahannya dapat diakses melalui scan QRCode yang terdapat pada sertifikat ini.



- UU ITE No. 11 Tahun 2008 Pasal 5 Ayat 1 "Informasi Elektronik dan/atau hasil cetaknya merupakan alat bukti hukum yang sah"
- Dokumen ini telah ditandatangani secara elektronik menggunakan sertifikat elektronik yang diterbitkan BSR - BSSN, validitas dokumen elektronik ini bisa dicek menggunakan aplikasi mobile VeryDS oleh BSR
- Cetak dokumen ini merupakan salinan dari file dokumen bertandatangan elektronik yang keabsahannya dapat diakses melalui scan QRCode yang terdapat pada sertifikat ini.



**Balai Besar  
Sertifikasi  
Elektronik**

# SKRIPSI

## DIAJUKAN UNTUK MELENGKAPI TUGAS DAN MEMENUHI SYARAT-SYARAT UNTUK MENCAPAI GELAR SARJANA KOMPUTER



|               |                                                                  |
|---------------|------------------------------------------------------------------|
| Pembimbing I  | Dr. Putu Hendra Suputra, S.Kom., M.Cs.<br>NIP.198212222006041001 |
| Pembimbing II | I Ketut Resika Arthana, S.T., M.Kom.<br>NIP.198412012012121002   |



- UU ITE No. 11 Tahun 2008 Pasal 5 Ayat 1 "Informasi Elektronik dan/atau hasil cetaknya merupakan alat bukti hukum yang sah"
- Dokumen ini telah ditandatangani secara elektronik menggunakan sertifikat elektronik yang diterbitkan BSrE - BSSN, validitas dokumen elektronik ini bisa dicek menggunakan aplikasi mobile VeryDS oleh BSrE
- Cetakan dokumen ini merupakan salinan dari file dokumen bertandatangan elektronik yang keabsahannya dapat diakses melalui scan QRCode yang terdapat pada sertifikat ini.

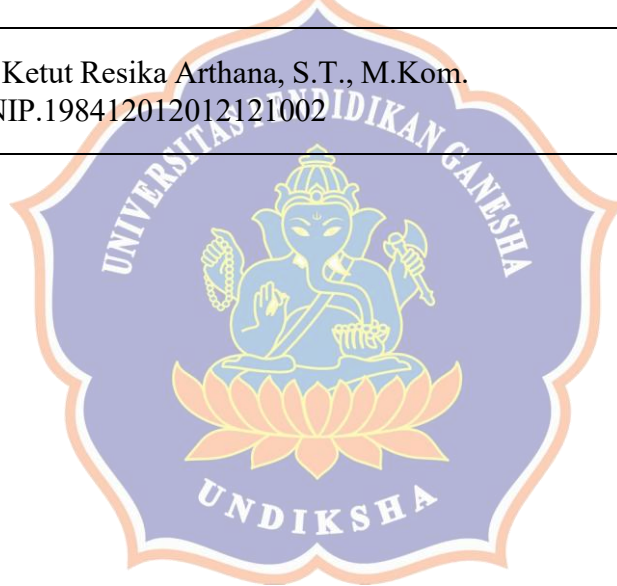


Balai Besar  
Sertifikasi  
Elektronik

Skripsi oleh I Kadek Bayu Danu Artha ini  
telah dipertahankan di depan dewan penguji  
Pada tanggal 01 Desember 2025

### Dewan Penguji

|         |                                                                          |
|---------|--------------------------------------------------------------------------|
| Ketua   | Ni Putu Novita Puspa Dewi, S.Kom., M.Cs., MIM.<br>NIP.199410032020122015 |
| Anggota | I Nyoman Saputra Wahyu Wijaya, S.Kom., M.Cs.<br>NIP.198910262019031004   |
| Anggota | Dr. Putu Hendra Suputra, S.Kom., M.Cs.<br>NIP.198212222006041001         |
| Anggota | I Ketut Resika Arthana, S.T., M.Kom.<br>NIP.198412012012121002           |



- UU ITE No. 11 Tahun 2008 Pasal 5 Ayat 1 "Informasi Elektronik dan/atau hasil cetaknya merupakan alat bukti hukum yang sah"
- Dokumen ini telah ditandatangani secara elektronik menggunakan sertifikat elektronik yang diterbitkan BSrE - BSSN, validitas dokumen elektronik ini bisa dicek menggunakan aplikasi mobile VeryDS oleh BSrE
- Cetakan dokumen ini merupakan salinan dari file dokumen bertandatangan elektronik yang keabsahannya dapat diakses melalui scan QRCode yang terdapat pada sertifikat ini.

Diterima oleh Panitia Ujian Fakultas Teknik dan Kejuruan  
Universitas Pendidikan Ganesha  
guna memenuhi syarat-syarat untuk mencapai gelar Sarjana Komputer

**Menyetujui**

|                  |                                                                         |
|------------------|-------------------------------------------------------------------------|
| Ketua Ujian      | Made Windu Antara Kesiman, S.T., M.Sc., Ph.D.<br>NIP.198211112008121001 |
| Sekretaris Ujian | I Nyoman Saputra Wahyu Wijaya, S.Kom., M.Cs.<br>NIP.198910262019031004  |



- UU ITE No. 11 Tahun 2008 Pasal 5 Ayat 1 "Informasi Elektronik dan/atau hasil cetaknya merupakan alat bukti hukum yang sah"
- Dokumen ini telah ditandatangani secara elektronik menggunakan sertifikat elektronik yang diterbitkan BSrE - BSSN, validitas dokumen elektronik ini bisa dicek menggunakan aplikasi mobile VeryDS oleh BSrE
- Cetakan dokumen ini merupakan salinan dari file dokumen bertandatangan elektronik yang keabsahannya dapat diakses melalui scan QRCode yang terdapat pada sertifikat ini.

## DECLARATION

I hereby declare that the written work titled **“Model Development For Push Up Counting By Utilizing Body Landmarks And LSTM Algorithm”** and its entirety are genuinely my original work, create without engaging in plagiarism or improper citation practices that violate the ethical standards of the scientific community. By making this declaration, I accept full responsibility for any sanctions that may be imposed if any violations if scientific ethics or challenges to the authenticity of my work are later discovered.

Singaraja, December 20, 2025

The one that makes a statement



I Kadek Bayu Danu Artha  
NIM 2115101025

## FOREWORD

The author express gratitude to God Almighty for His blessings, which enabled author to complete this undergraduate thesis entitled **<Model Development for Push-Up Counting by Utilizing Body Landmarks and LSTM Algorithm.>** This undergraduate thesis was written to fulfill the requirements for a bachelor's degree in Computer Science at Universitas Pendidikan Ganesha. In completing this undergraduate thesis, the author received a great deal of assistance, both moral and material, from various parties. Therefore, the author would like to take this opportunity to express his gratitude to:

1. Prof. Dr. I Wayan Lasmawan, M.Pd., as the Rector of Universitas Pendidikan Ganesha, who has provided educational facilities for the author in the university environment.
2. Dr. Kadek Rihendra Dantes, S.T., M.T., as the Dean of the Faculty of Engineering and Vocational Universitas Pendidikan Ganesha, who has provided educational facilities for the author in the university environment.
3. Dr. Putu Hendra Saputra, S.Kom., M.Cs., as the Head of the Department of Informatics Engineering and as a supervisor who has provided valuable advice on topics, motivation, and input in the implementation of research.
4. I Nyoman Saputra Wahyu Wijaya, S.Kom., M.Cs., as the Coordinator of the Computer Science Study Program, second examiner, and academic advisor to the author, who has provided academic guidance and input in the preparation of this undergraduate thesis.
5. I Ketut Resika Arthana, S.T., M.Kom., as the second supervisor, who provided valuable input in the implementation of this research.
6. Ni Putu Novita Puspa Dewi, S.Kom., M.Cs., MIM. as the examiner who has provided valuable input and advice in the implementation of this research and the writing of this thesis

7. All lecturers in the Informatics Engineering Department or Computer Science Study Program who have provided knowledge, experience, motivation, and enthusiasm during the author's studies at Universitas Pendidikan Ganesha.
8. The Commander of Secata Rindam IX/Udayana, who granted the author permission to collect the data used in this study.
9. Komang Somyadyana as the validator who validated the research data and labeled each class.
10. The trainers and new soldiers of the Indonesian Army at Secata Rindam IX/Udayana from July to September who helped demonstrate push-up movements as research data.
11. The author's parents, Ir. I Nengah Kari and Ni Nyoman Suryani, and the author's brother, I Gede Arta Suryawan, who always provided support and prayed for the author's success.
12. Komang Dian Sri Indahswari, as the author's special person who provided emotional support and helped the author in recording the data.
13. Friends who helped record the data, namely Putu Adi Widyantara, Putu Gede Dimas Witjaksana, Putu Adi Sastrawan, and Ngakan Gde Astria Abirama.
14. I Kadek Prasta Yudhantara and Dewa Komang Reiki Perdana Wisnu as demonstrators for the simulation program testing data that was developed.
15. All parties who have assisted that the author cannot mention one by one.

The author realizes that this undergraduate thesis is not without flaws. Therefore, constructive feedback and suggestions from various parties are greatly appreciated. It is hoped that this undergraduate thesis will be useful to those who need it.

Singaraja, December 22, 2025

Author

## TABLE OF CONTENTS

|                                           |     |
|-------------------------------------------|-----|
| FOREWORD.....                             | i   |
| TABLE OF CONTENTS .....                   | iii |
| LIST OF TABLES .....                      | v   |
| LIST OF IMAGES .....                      | v   |
| LIST OF APPENDICES .....                  | vi  |
| CHAPTER I INTRODUCTION .....              | 1   |
| 1.1. Background.....                      | 1   |
| 1.2. Problem Limitation .....             | 4   |
| 1.3. Problem Statement.....               | 5   |
| 1.4. Research Objectives.....             | 5   |
| 1.5. Research Benefits .....              | 6   |
| CHAPTER II LITERATURE REVIEW.....         | 7   |
| 2.1. Review Of Literature .....           | 7   |
| 2.2. Theoretical Foundation.....          | 16  |
| 2.2.1. Push-Up .....                      | 16  |
| 2.2.2. MediaPipe.....                     | 18  |
| 2.2.3. Long-Short Term Memory (LSTM)..... | 21  |
| 2.2.4. TensorFlow.....                    | 24  |
| 2.2.5. Padding.....                       | 26  |
| 2.2.6. Accuracy.....                      | 27  |
| 2.2.7. Precision .....                    | 28  |
| 2.2.8. Latency .....                      | 29  |
| CHAPTER III RESEARCH METHODS.....         | 30  |
| 3.1. Research Type and Data Source .....  | 30  |
| 3.2. Research Design .....                | 30  |
| 3.2.1. Data Collection.....               | 31  |

|                                         |                                 |     |
|-----------------------------------------|---------------------------------|-----|
| 3.2.2.                                  | Video Data Processing .....     | 33  |
| 3.2.3.                                  | Landmark Extraction .....       | 37  |
| 3.2.4.                                  | Feature Extraction .....        | 37  |
| 3.2.5.                                  | Dataset Construction.....       | 38  |
| 3.2.6.                                  | Model Training.....             | 38  |
| 3.2.7.                                  | Evaluation.....                 | 39  |
| CHAPTER IV RESULTS AND DISCUSSION ..... |                                 | 41  |
| 4.1.                                    | Results .....                   | 41  |
| 4.1.1.                                  | Data Collection.....            | 41  |
| 4.1.2.                                  | Video Data Processing .....     | 42  |
| 4.1.3.                                  | Landmark Extraction.....        | 44  |
| 4.1.4.                                  | Feature Extraction .....        | 46  |
| 4.1.5.                                  | Dataset Development.....        | 49  |
| 4.1.6.                                  | Training Model.....             | 50  |
| 4.1.7.                                  | Evaluation.....                 | 65  |
| 4.2.                                    | Discussion.....                 | 71  |
| 4.2.1.                                  | Data Processing.....            | 72  |
| 4.2.2.                                  | Model Training and Testing..... | 76  |
| 4.2.3.                                  | Simulation Implementation ..... | 89  |
| CHAPTER V CLOSING.....                  |                                 | 97  |
| 5.1.                                    | Conclusion .....                | 97  |
| 5.2.                                    | Suggestion.....                 | 99  |
| LITERATURE .....                        |                                 | 101 |
| APPENDIX .....                          |                                 | 107 |

## LIST OF TABLES

|                                                                          |    |
|--------------------------------------------------------------------------|----|
| Table 2.1 Illustration of the Masking Padding Process .....              | 26 |
| Table 3.1 Example of Data Capture Angle .....                            | 32 |
| Table 3.2 Examples of Data Showing Correct and Incorrect Movements ..... | 35 |
| Table 4.2 Data Distribution for Each Class Based on Camera Angle.....    | 42 |
| Table 4.3 List Library Used.....                                         | 44 |
| Table 4.4 Initial Model Structure References.....                        | 51 |
| Table 4.5 List of Layer Structure .....                                  | 52 |
| Table 4.6 Model Training Loss Validation Value.....                      | 54 |
| Table 4.7 Model Training Validation Accuracy Value .....                 | 54 |
| Table 4.8 First Stage Testing Model Accuracy .....                       | 55 |
| Table 4.9 Recall and F1-Score First Stage Training Testing .....         | 55 |
| Table 4.10 Results of Learning Rate Change Trial Training .....          | 57 |
| Table 4.11 Testing the Model Results of Learning Rate Changes .....      | 60 |
| Table 4. 12 Recall and F1-Score Testing Learning Rate Changes .....      | 61 |
| Table 4.13 Results of Regularization Addition Trial Training.....        | 62 |
| Table 4.14 Regularisation Addition Trial Testing.....                    | 63 |
| Table 4.15 Recall and F1-Score Testing of Regularization Addition .....  | 63 |
| Table 4.16 The Best Layer Model Structure .....                          | 65 |
| Table 4.17 Simulation Video Testing Details .....                        | 67 |
| Table 4.18 List of Testing Devices .....                                 | 67 |
| Table 4.19 Simulation Test Results Device Intel Core i5-1240P.....       | 68 |
| Table 4.20 Simulation Test Results Device AMD Ryzen 7 5700U .....        | 68 |
| Table 4.21 Simulation Test Results Device Intel Core i3-1115G4 .....     | 69 |
| Table 4. 22 Simulation Test Results Device Intel Core i5-1135G7 .....    | 69 |

|                                                                                                       |    |
|-------------------------------------------------------------------------------------------------------|----|
| Table 4.23 Example of a Data Frame with Poor Extraction.....                                          | 72 |
| Table 4.24 Confusion Matrix Fold with the Highest Testing Accuracy of 8 First Stage Model.....        | 77 |
| Table 4.25 Confusion Matrix Fold with the Lowest Testing Accuracy of 8 Models in the First Stage..... | 80 |
| Table 4.26 Data on Changes in Y-Coordinate of Shoulder in Still Video Data....                        | 92 |
| Table 4.27 Delta Y Shoulder Chart and Up-Down Detection Results .....                                 | 92 |



## LIST OF IMAGES

|                                                                            |    |
|----------------------------------------------------------------------------|----|
| Figure 2.1 Push-up Starting Position.....                                  | 18 |
| Figure 2.2 Upper Position Push-Up.....                                     | 18 |
| Figure 2.3 MediaPipe Pose Process.....                                     | 20 |
| Figure 2.4 33 Keypoints Human Body.....                                    | 20 |
| Figure 2.5 LSTM Architecture.....                                          | 22 |
| Figure 3.1 Research Design.....                                            | 31 |
| Figure 4.1 Export Setting Video In CapCut.....                             | 44 |
| Figure 4.2 Results Body Side Detection.....                                | 48 |
| Figure 4.3 Code For Calculate Angle.....                                   | 49 |
| Figure 4.4 Searching for Minimum and Maximum Values in Data.....           | 50 |
| Figure 4. 5 Longest and Shortest Data Searches.....                        | 50 |
| Figure 4.6 Branching to Determine 1 Repetition Performed.....              | 66 |
| Figure 4 7 Kernel Experiencing Restarting During Testing.....              | 70 |
| Figure 4.8 Screenshot of Task Manager When CPU Overload.....               | 70 |
| Figure 4.9 Example Frame of Lower Position incorrect-down-half.....        | 86 |
| Figure 4. 10 Exampel Frame of Lower Position Class correct.....            | 86 |
| Figure 4.11 Example Frame of Lower Position Class incorrect-hip-up.....    | 88 |
| Figure 4.12 Example Frame of Lower Position Class incorrect-down-half..... | 88 |
| Figure 4.13 Example Frame of Lower Position Class correct.....             | 88 |

## LIST OF APPENDICES

|                                                                    |     |
|--------------------------------------------------------------------|-----|
| Appendix 01 Data Retrieval Request Form.....                       | 108 |
| Appendix 02 Department Application Letter .....                    | 109 |
| Appendix 03 Data Retrieval Request Letter.....                     | 110 |
| Appendix 04 Data Collection Statement Letter.....                  | 111 |
| Appendix 05 Simulation Code Link and Barcode.....                  | 112 |
| Appendix 06 Simulation Testing Documentation Barcode and Link..... | 112 |

