Breaking the World Record:

Building the Smallest Humanoid Robot

# ‏Introduction

‏In the world of robotics, pushing boundaries is the name of the game. My journey began with a simple goal: to break the world record for the smallest humanoid robot and keeping the price as low as possible. The existing record stood at 141mm, and I was determined to surpass it.

# ‏Development Plan

‏From the outset, my motivation was clear: to challenge myself and push the limits of what is possible, I wanted to make the smallest and cheapest robot possible. I started by researching existing designs and looking for the smallest motors, controllers, Bluetooth modules and motor drivers. Armed with this knowledge, I embarked on the ambitious task of designing and building my own miniature robot.

Throughout the development process, I encountered numerous challenges, from sourcing miniature components and optimizing space and weight constraints to reverse engineering communication protocols. However, each obstacle was an opportunity to innovate and refine my design further.

To keep the budget as low as possible I set a goal to use only off the shelf Chinese parts, not using any custom or expensive parts or equipment. Also I limited my self to using only 3d printed parts and design everything from scratch.

The heart of the project is making the robot move its joints, for that I need many tiny motors, I figured out that although a simple DC motor might cut the hight and weight, using anything other than a servo driver will complicate the design significantly. So, I went with the 1g servo motor I found on AliExpress [LINK].

The brain is a microcontroller that should be capable of running my “very complex code”, controlling many servo motors and communicating over Bluetooth or Wi-Fi to be remote controlled by a phone or computer. My initial thought was to use a good old ESP32 I had laying around, along with a Adafruit PCA9685 16-Channel Servo Driver [LINK] to control the motors.

For powering this tiny beast, I ordered a pair of 200mah lipo batteries along with a tiny step-up converter to handle the 5v required by the servo motors.

And that was it for the parts list, anything was impulsively ordered on AliExpress at 3AM, and I quickly opened a request to break the world record with the ambition to reach 100mm which is nearly a 30% improvement over the previous record.

# ‏Progress Updates

‏As I made progress, I documented each milestone with photos and videos, sharing my journey with friend and family. From initial sketches to prototype iterations, the evolution of my robot was a testament to perseverance and determination.

Week #1

The PCA9685 servo driver was huge taking up 62mm! I knew this wont be possible to cram up ESP32, battery, huge servo driver, wirings and more into a robot the should have humanoid proportions and not wide like a shoe box.

I looked for many solutions and I found an all-in-one solution! “WitMotion 16 Channel Bluetooth PWM Servo Driver” [LINK+imAGE] A microcontroller along with Bluetooth module and 16 channel servo driver, all on one board. And the size was only 43mm\*36mm which is a 33% improvement and reduce the number of parts by half. The device also comes with an pc software and an android app, I don’t have an android device myself, but I figured it wont be a problem. I quickly bought this board and waited another week.

Week #2

The WitMotion board arrived, since I don’t have an android device I downloaded the pc software [IMAGE] and quickly realised it wont be good enough to control the robot, the UI and features are not comfortable and it only works over a USB (UART) connection.

I tried to sniff the UART communication data and saw a relatively simple protocol with only a few bytes of data. I noticed a periodic packet every 1 second this looked to me like a keepalive mechanism, so i tried to connect with pyserial and send the same keepalive message and got the expected response from the board! From now I know that communication with the board is possible with a python script and all that is left to do is analysing the rest of the protocol, so i returned to the commercial software and tried to sniff more commands, the motor control packet was as simple as 5 bytes with a very intuitive structure [IMAGE].

I made a python package for communicating with the microcontroller, the package is capable of 5 commands which is all that is necessary for the robot. The commands that are not supported are uploading and erasing entire programs to the board for offline use. You can find this package on PyPi [LINK]

Week #3

So now I’m able to control the robot with the new board but only when it is wired, I needed to analyse the Bluetooth communication protocol as well but i didn’t have the knowledge not an android device for using the commercial app. Nevertheless I downloaded an IOS app for Bluetooth communication and I manage to identify the right mac address for the board and I saw it identified as “Nordic UART”, after a google search I realised this was going to be easier than expected since “Nordic UART” is a way to use the same UART communication protocol over the Bluetooth. I sent the keep alive message over Bluetooth and got the right response! After that I checked all the other commands and it works exactly like the USB connection.

After realising that the protocol is the same and only the medium is different I went ahead and tried to look on GitHub for a “Nordic UART” package to make my life easier – but nothing found. I decided to implement my own communication package that will have a similar API to the PySerial package to be able to polymorphism and use both serial or Bluetooth communication interchangeably. You can find it on PyPi [LINK]

Week #4

Two main tasks ahead, One is to finish the CAD design process and 3D print all the parts and the other is to finish the software part and implements some animation logic.

Both task were straight forward and here are the results:

[Github Link]

[CAD Images]

After weeks of hard work and countless iterations, I proudly present my final creation: Tiny Titan. Standing at just 95mm high, Tiny Titan is a marvel of miniaturization, it represents the culmination of countless hours of design, experimentation, and refinement.

Week #5 - Attempt at the Record

‏With my robot in hand, I prepared for the record-breaking attempt., I.

At that point a got a mail from Guinness World Records that my submission request was reviewed and approved and now all that’s left is to provide evidence and documentation. This step was the hardest one for me since It requires Following the strict guidelines set by Guinness World Records, meticulously documenting every aspect of the process, from measurements to verification methods , 2 witnesses, 1 Expert in the field to vouch for the build process and another measurement made by someone that is qualified to make measurements. I thought this journey could be completed without leaving my bedroom, but now I’m forced to talk to people ;(

At that point My procrastination hit the hardest, I was distracted by my job and my school and made excuses to not finish this projects and send the documents. I later realised this was a bitter mistake.

Week #10 – Procrastination Results

Unfortunately, before I could receive confirmation, another individual broke the record with a robot measuring just 60mm. While disappointed, I am proud of my achievement and the lessons learned along the way.

‏Congratulations to the new record holder for their remarkable achievement. Though my attempt fell short, I am inspired to continue pushing the boundaries of robotics and pursuing new challenges in the future.

# ‏Conclusion

‏Breaking the world record for the smallest humanoid robot was an unforgettable journey filled with highs and lows. I am grateful for the support of [mention anyone who supported or contributed] and the opportunity to share my experience with the Hackaday community. As I look to the future, I am excited to see where this journey will take me next.

# ‏Appendix

