WTLO

WASEDA Technology Licensing Organization

TECHNOLOGY OFFERS

ロボットワールド（3展総称）

サービスロボット展
産業用ロボット展
次世代モビリティ展

ROBOT WORLD

早稲田大学 リサーチイノベーションセンター　知財・研究連携支援セクション(承認ＴＬＯ)
WASEDA UNIVERSITY Research Innovation Center
Intellectual Property and Research Collaboration Support Section

超小形・軽量・安価な補助機器シリーズ①

振動スピーカによる歩行補助シューズ

Ultra-compact, lightweight, and reasonable assist device series 1:
Walking assist shoes with vibration speakers

背景／課題 Background/Problems

◆ 背景：超高齢社会，コロナ以降も出不精，脳卒中患者増加，患者をケアする介助者・労働者・若手不足．

◆ 課題1：病院・リハ施設に行かなくても手軽・安価に自身でリハビリ可能に，脳卒中予防に運動促進を実現．

◆ 課題2：歩行補助ロボットの多くはモータ・コンピュータ・バッテリ使用，サイズ・重量・価格を抑える必要有．

- Super-aging society, unwillingness to go outside even after the coronavirus, increasing number of stroke patients, lack of workers and young people to care for patients.
- Able to easily and inexpensively perform rehabilitation on our own without going to a hospital or rehabilitation facility.
- Promoting exercise to prevent stroke.
- Most assist devices use motors, computers, and batteries. Necessary to reduce size, weight, and price.

概要／解決法 Summary/Solutions

◆概要：患者には正しい歩き方（歩容）を身につけてもらう，フレイル・高齢者には歩くことを促進する．

◆解決法：小型振動スピーカで足をサンドイッチして非対称波形を入力し，適切なタイミングで足関節の底背屈動作の方向を「押されている感覚」によって直接足に伝え，歩くことを促進する．

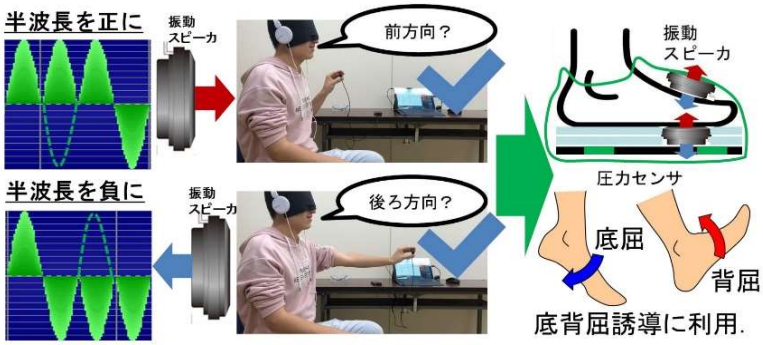
- Have patients learn the correct, Encourage frail and elderly people to walk.
- Sandwich the foot with a small vibration speaker and input an asymmetrical waveform, and at the appropriate timing, the direction of plantarflexion and dorsiflexion of the ankle joint is directly transmitted to the foot through the “feeling of being pushed” to promote walking.

優位性 Advantages

◆ モータ不使用のため小形・軽量・安価に製作可能．

◆ 健常者3名15分歩行実験結果より，非装着時及びモータアシスト時よりも底背屈動作範囲が拡大．

◆ スピーカを小型化すれば，靴内に薄い中敷を挿入するだけで使用可能．現在シューズは500g．



- Since it does not use a motor, it can be made small, lightweight, and inexpensive.
- Based on the results of a 15-minute walking experiment with three healthy participants, the range of plantarflexion and dorsiflexion was expanded compared to when the device was not worn or when motor assist was applied.
- If the speaker is made smaller, it can be used by simply inserting a thin insole into user’s shoes. Current weight: 500g

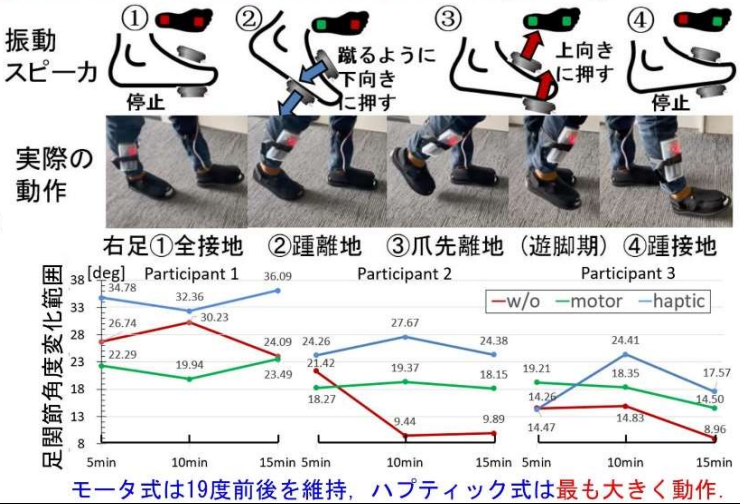
ターゲット市場／製品 Target Areas/Products

◆ 病院・リハビリ施設（リハビリテーション用）

◆ 高齢者運動施設や健常者健康グッズ（運動促進用）

◆ 特許出願中，「歩行補助機」，特願2021-190328

- Hospital/rehabilitation facility (for rehabilitation)
- Exercise facilities for the elderly and health goods for healthy people (for promoting exercise)
- Applied for a patent



モータ式は19度前後を維持，ハプティック式は最も大きく動作．

研究者名 ：田中英一郎　　所属 ：理工学術院　大学院情報生産システム研究科

超小形・軽量・安価な補助機器シリーズ②
モータレス式メカニカル歩行補助器
Ultra-compact, lightweight, and reasonable assist device series 2:
Mechanical walking assist device without motors

背景／課題 Background/Problems

◆ 背景：超高齢社会，コロナ以降も出不精，脳卒中患者増加，患者をケアする介助者・労働者・若手不足．

◆ 課題1：病院・リハ施設に行かなくても手軽・安価に自身でリハビリ可能に，脳卒中予防に運動促進を実現．

◆ 課題2：歩行補助ロボットの多くはモータ・コンピュータ・バッテリ使用，サイズ・重量・価格を抑える必要有．

- Super-aging society, unwillingness to go outside even after the coronavirus, increasing number of stroke patients, lack of workers and young people to care for patients.
- Able to easily and inexpensively perform rehabilitation on our own without going to a hospital or rehabilitation facility.
- Promoting exercise to prevent stroke.
- Most assist devices use motors, computers, and batteries. Necessary to reduce size, weight, and price.

概要／解決法 Summary/Solutions

◆概要：患者には正しい歩き方（歩容）を身につけてもらう，フレイル・高齢者には歩くことを促進する．

◆解決法：ばねと機構のみで動作し，適切なタイミングで足関節の底背屈動作をばねの力によって補助し，歩くことを促進する．

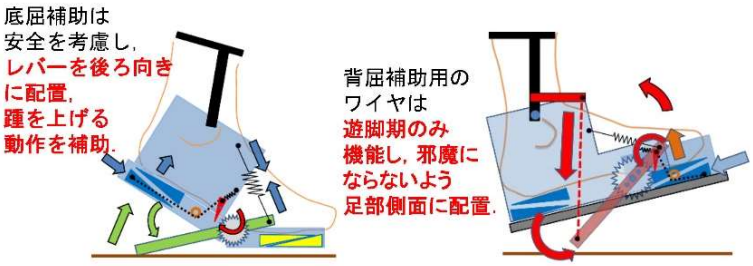
- Have patients learn the correct, Encourage frail and elderly people to walk.
- Consists only of a spring and a mechanism, and uses the force of the spring to assist plantarflexion and dorsiflexion of the ankle joint at the appropriate time, promoting walking.

優位性 Advantages

◆ モータ不使用のため小形・軽量・安価に製作可能．

◆ 健常者3名の歩行動作・筋活動解析結果より，底背屈動作範囲が拡大，筋活動低減．

◆ 機構を全て靴のソール内に含めれば，靴と同程度のサイズで実現可能．現在約1kg．



- Since it does not use a motor, it can be made small, lightweight, and inexpensive.
- Analysis of walking motion and muscle activity in three healthy subjects showed that the range of plantarflexion and dorsiflexion was expanded and muscle activity was reduced.
- If all the mechanisms are included in the sole of the shoe, it can be realized with the same size as a shoe. Currently about 1kg.

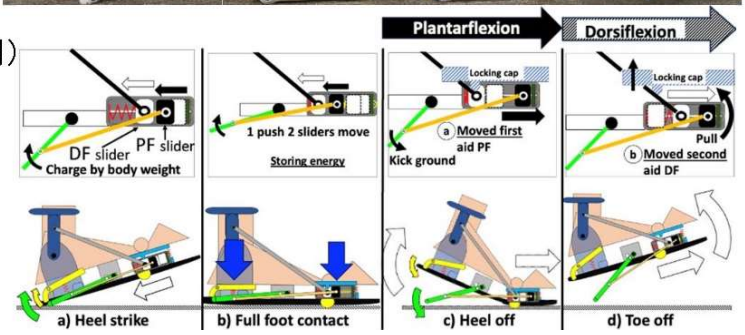
ターゲット市場／製品 Target Areas/Products

◆ 病院・リハビリ施設（リハビリテーション用）

◆ 高齢者運動施設や健常者健康グッズ（運動促進用）

◆ 特許出願中，「歩行補助装置」，特願2023-034090

- Hospital/rehabilitation facility (for rehabilitation)
- Exercise facilities for the elderly and health goods for healthy people (for promoting exercise)
- Applied for a patent



研究者名 ：田中英一郎　　所属 ：理工学術院　大学院情報生産システム研究科

超小形・軽量・安価な補助機器シリーズ③
装着者に合わせ誘導する歩行補助機

Ultra-compact, lightweight, and reasonable assist device series 3:
Walking assist device that guides according to the wearer's walk

背景／課題 Background/Problems

◆ 背景：超高齢社会，コロナ以降も出不精，脳卒中患者増加，患者をケアする介助者・労働者・若手不足．

◆ 課題1：病院・リハ施設に行かなくても手軽・安価に自身でリハビリ可能に，脳卒中予防に運動促進を実現．

◆ 課題2：従来の補助機は設定した周期・歩幅で訓練，自動的に装着者に合わせて動作を誘導する必要有．

- Super-aging society, unwillingness to go outside even after the coronavirus, increasing number of stroke patients, lack of workers and young people to care for patients.
- Able to easily and inexpensively perform rehabilitation on our own without going to a hospital or rehabilitation facility.
- Promoting exercise to prevent stroke.
- With conventional assist devices, the cycle and stride length had to be set Necessary to automatically guide the motion according to the wearer.

概要／解決法 Summary/Solutions

◆概要：患者には正しい歩き方（歩容）を身につけてもらう，フレイル・高齢者には歩くことを促進する．

◆解決法：足関節の底背屈動作をモータによって補助するが，今の歩行周期・歩幅を自動的に推定し，かつ各歩行位相にて常に装着者より早く動作する．これにより，どんな速度でも常に装着者に歩行を促す．

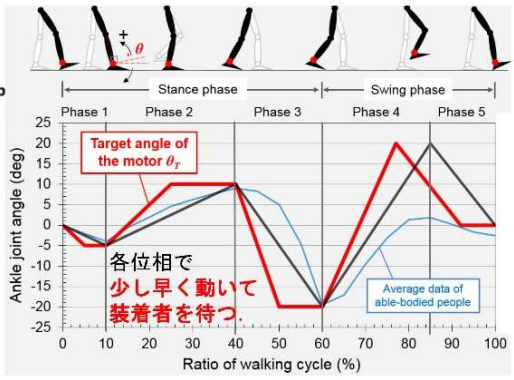
- Have patients learn the correct, Encourage frail and elderly people to walk.
- The plantar dorsiflexion of the ankle joint is assisted by a motor, which automatically predicts the current walking cycle and stride length, and always moves faster than the wearer in each walking phase. This always encourages the wearer to walk at any speed.

優位性 Advantages

◆ 足関節のみ補助のため小形・軽量に製作可能．

◆ 健常者3名の歩行動作解析結果より，約96%の精度で歩行周期の推定実現を確認．

◆ 感情・疲労評価システムとの連動可能，疲労に配慮しながら感情を高め，歩行距離増加を確認．



- Can be made small and lightweight because it only supports the ankle joint.
- Based on the walking motion analysis results of three healthy participants, we confirmed that the walking cycle could be estimated with approximately 96% accuracy.
- It was confirmed that it can be linked with the real-time emotion/fatigue evaluation system, enhances emotions while taking fatigue into consideration, and increases walking distance.

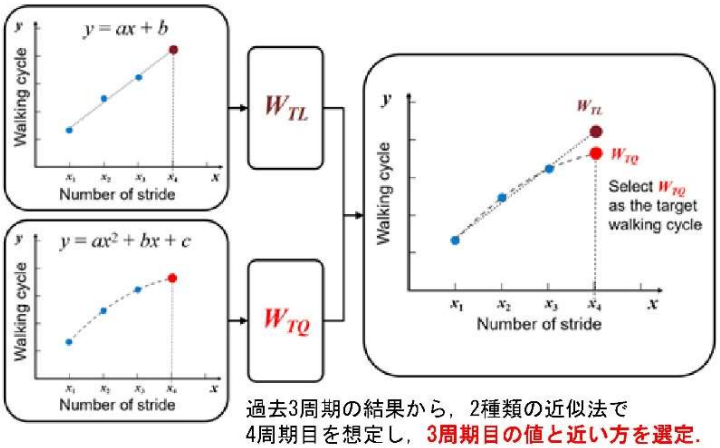
ターゲット市場／製品 Target Areas/Products

◆ 病院・リハビリ施設（リハビリテーション用）

◆ 高齢者運動施設や健常者健康グッズ（運動促進用）

◆ 特許出願中，「歩行補助装置、制御装置、及び制御プログラム」，特願2023-100405

- Hospital/rehabilitation facility (for rehabilitation)
- Exercise facilities for the elderly and health goods for healthy people (for promoting exercise)
- Applied for a patent

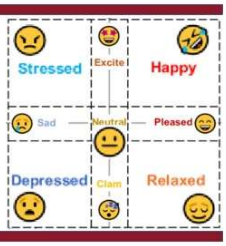


過去3周期の結果から，2種類の近似法で
4周期目を想定し，**3周期目の値と近い方を選定．**

研究者名 ：田中英一郎　　所属 ：理工学術院　大学院情報生産システム研究科

超小形・軽量・安価な補助機器シリーズ④
リアルタイム感情・疲労評価システム

Ultra-compact, lightweight, and reasonable assist device series 4:
A system that evaluates emotions and fatigue in real time



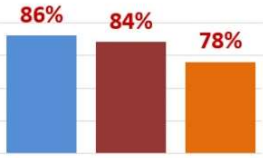
背景／課題 Background/Problems

◆ 背景：超高齢社会，コロナ以降も出不精，脳卒中患者増加，患者をケアする介助者・労働者・若手不足．

◆ 課題1：病院・リハ施設に行かなくても手軽・安価に自身でリハビリ可能に，脳卒中予防に運動促進を実現．

◆ 課題2：リハビリや運動は，疲れる，痛い，つらいことからなかなか続かない．高いモチベーション維持が必要．

- Super-aging society, unwillingness to go outside even after the coronavirus, increasing number of stroke patients, lack of workers and young people to care for patients.
- Able to easily and inexpensively perform rehabilitation on our own without going to a hospital or rehabilitation facility.
- Promoting exercise to prevent stroke.
- With conventional assist devices, the cycle and stride length had to be set Necessary to automatically guide the motion according to the wearer.



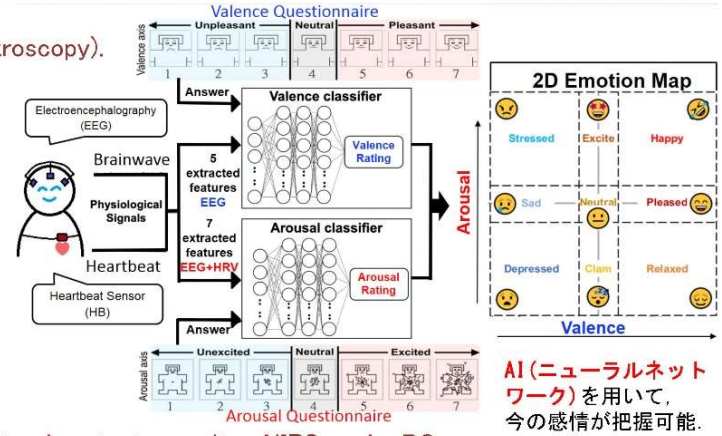
脳波のみでも快-不快，覚醒-睡眠を評価できるが，心拍を使用すると**推定精度がより高くなる．**

概要／解決法 Summary/Solutions

◆概要：患者の訓練やフレイル・高齢者の運動を，快かつ覚醒した感情で取り組み，高効率に成果を出す．

◆解決法：AI（ニューラルネットワーク）を用いて，対象者の脳波と心拍から，快-不快軸（気持ち良さ），覚醒-睡眠軸（興奮度）の2次元で感情をリアルタイムに評価する．また，NIRS（近赤外分光法）にて筋疲労を評価する．

- Train patients and exercise for frail and elderly people with pleasant and aroused emotions and achieve highly efficient results.
- AI (neural networks), evaluate the subject's emotions in real time based on their brain waves and heartbeat in two dimensions: Valence axis (pleasure) and Arousal axis (excitement).
- Muscle fatigue can be evaluated using NIRS (near infrared spectroscopy).



AI（ニューラルネットワーク）を用いて，今の感情が把握可能．

優位性 Advantages

◆ 市販の脳波計，心拍計，NIRSとPCのみで構成可能．

◆ 健常者20名のビデオ鑑賞時のアンケート結果と比較して，精度約85%で感情を推定実現を確認．

◆ 歩行補助機の連動可能，疲労に配慮しながら感情を高め，歩行距離増加を確認．

- Can be configured using only a commercially available EEG monitor, heart rate monitor, NIRS, and a PC.
- Comparing the results of a questionnaire survey of 20 healthy people while watching videos, we confirmed that emotions could be estimated with an accuracy of approximately 85%.
- Can be linked to walking aids, heightening emotions while taking into account fatigue, and confirming an increase in walking distance.

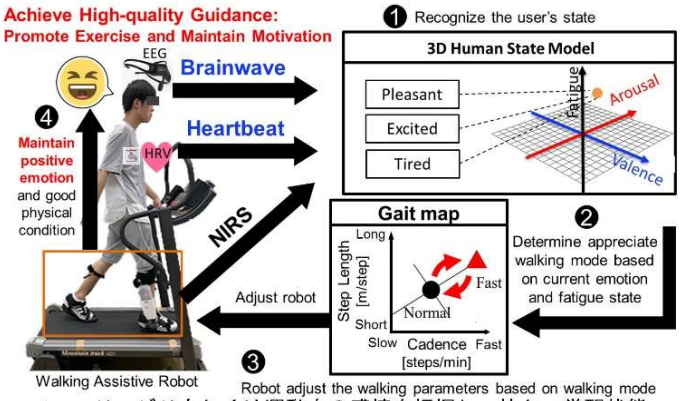
ターゲット市場／製品 Target Areas/Products

◆ 病院・リハビリ施設（リハビリテーション用）

◆ 高齢者運動施設（運動促進用）や職場でのメンタル診断

◆ Yunfan Li, et al., JRM, Vol. 34, No. 6, pp. 1383-1397, (2022). Yongxin Wei, et al., SII2023, pp. 975-980, (2023).

- Hospital/rehabilitation facility (for rehabilitation)
- Exercise facilities for the elderly and mental diagnosis
- Journal paper: Yunfan Li, et al., JRM, Vol. 34, No. 6, pp. 1383-1397, (2022). Proceeding: Yongxin Wei, et al., SII2023, pp. 975-980, (2023).



リハビリもしくは運動中の感情を把握し，快かつ覚醒状態へ誘う歩容を入力，疲労を確認しながら**高効率に効果を得る．**

研究者名 ：田中英一郎　　所属 ：理工学術院　大学院情報生産システム研究科

超小形・軽量・安価な補助機器シリーズ⑤
腕を下から支え追従する上肢補助器

Ultra-compact, lightweight, and reasonable assist device series 5:
An upper limb device that supports and follows the arm from bottom

背景／課題 Background/Problems

◆ 背景：超高齢社会，コロナ以降も出不精，脳卒中患者増加，患者をケアする介助者・労働者・若手不足．

◆ 課題1：病院・リハ施設での腕を上げにくい患者の動作補助，介護・工場・農業等各種作業者の負担軽減．

◆ 課題2：モータ等の動力源があると，かさばり，屋外や浴場，ビニルハウス，冷凍室等の環境では使用困難．

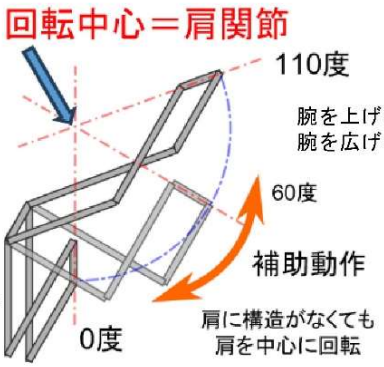
- Super-aging society, unwillingness to go outside even after the coronavirus, increasing number of stroke patients, lack of workers and young people to care for patients.
- Motion assistance for patients who have difficulty raising their arms in hospitals and rehabilitation facilities,
- Reducing the burden on various workers in nursing care, factories, agriculture, etc.
- If there is a power source such as a motor, it is bulky and difficult to use it outdoors, in bathrooms, vinyl houses, freezers, etc.

概要／解決法 Summary/Solutions

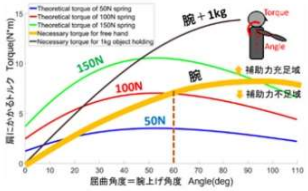
◆概要：腕の重さ分の負担を軽減．腕が角度を変えても追従，体の側面からはみ出さず他と干渉しない．

◆解決法：遠隔運動中心（Remote Center of Motion）機構を用い，補助したい肩周りには機構がなくても肩関節を中心とした腕を上げる動作に追従，上腕の下（裏）から持ち上げるよう支持．電源不要のガススプリング使用．

- Reduces the burden of arm weight. Even if the arm changes its angle, it will follow and will not protrude from the side of the body and will not interfere with others.
- By using a Remote Center of Motion mechanism, even if there is no mechanism around the shoulder, it follows the motion of raising the arm centered around the shoulder joint, and assists from the bottom (back) of the upper arm.
- Uses a gas spring that requires no power supply.



腕を上げるだけでなく，腕を広げる動作も追従．
外転：0~115度
屈曲：0~110度



100Nばね　：腕のトルクカーブに近い
　　：60度で腕の重さと釣り合う

優位性 Advantages

◆ モータ不使用のため小形・軽量・安価に製作可能．

◆ 装着者の正面と側面に機構が来ず，ぶつからない．

◆ 健常者3名が装着し，作業時の筋活動を筋電位の%MVC平均値にて算出し，非装着時と比較した結果，三角筋前部: −38%, 中部: −31%, 後部: −11%を確認．

- Since it does not use a motor, it can be manufactured compactly, lightweight, and inexpensively.
- The mechanism does not come in front of or on the sides of the wearer, preventing collisions with other people or objects.
- The device was worn by three healthy participants, and the muscle activity during work was calculated using the average % MVC of EMG, and the results were compared to without the device: anterior deltoid: −38%, middle: −31%, rear deltoid muscle : −11%.

ターゲット市場／製品 Target Areas/Products

◆ 病院・リハビリ施設（患者の日常生活動作補助用）

◆ 介護・工場・農業等各種作業従事者および企業（作業補助用）

◆ 特許出願中．

- Hospitals/rehabilitation facilities (for assisting patients with activities of daily living)
- For nursing care, factories, agriculture, etc. workers and companies (for work assistance)
- Applied for a patent

使用例：
日常生活
および
各種作業に
使用可能．

研究者名 ：田中英一郎　　所属 ：理工学術院　大学院情報生産システム研究科

超小形・軽量・安価な補助機器シリーズ⑥
腕・背中・膝を連動して補助するスーツ

Ultra-compact, lightweight, and reasonable assist device series 6:
A suit that interlocks arms, back, and knees to assist

背景／課題 Background/Problems

◆ 背景：超高齢社会，コロナ以降も出不精，脳卒中患者増加，患者をケアする介助者・労働者・若手不足．

◆ 課題1：患者や高齢者，フレイルの事故が多い着座動作を補助，介護・工場・農業等各種作業者の負担軽減．

◆ 課題2：モータ等の動力源があると，かさばり，屋外や浴場，ビニルハウス，冷凍室等の環境では使用困難．

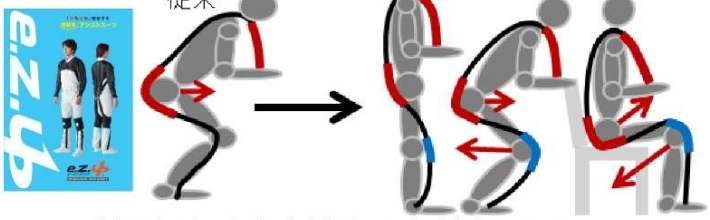
- Super-aging society, unwillingness to go outside even after the coronavirus, increasing number of stroke patients, lack of workers and young people to care for patients.
- Assists patients, the elderly, and frail people with sitting movements that often cause accidents.
- Reducing the burden on various workers in nursing care, factories, agriculture, etc.
- If there is a power source such as a motor, it is bulky and difficult to use it outdoors, in bathrooms, vinyl houses, freezers, etc.

概要／解決法 Summary/Solutions

◆概要：腕と背中（腰）を補助するスーツは開発済み（e.z.UP®），さらに起立・着座・中腰作業時の膝補助が必要．

◆解決法：伸縮生地とゴムベルトを使用したe.z.UP®を基に，背中から膝上にベルトを介し，足裏に至る構造追加．

- A suit that supports the arms and back (lower back) has been developed (e.z.UP®), and knee support is also required when standing, sitting, and working in a half sitting posture.
- Based on e.z.UP®, which uses stretchable fabric and a rubber belt, we added a structure that runs from the back to above the knees, through the belt, to the soles of the feet.



従来モデル(左)：上腕と背中をゴムベルトで補助(e.z.UP®)
新モデル(右)：上腕と背中に加えて膝に搭載したゴムベルトで補助

優位性 Advantages

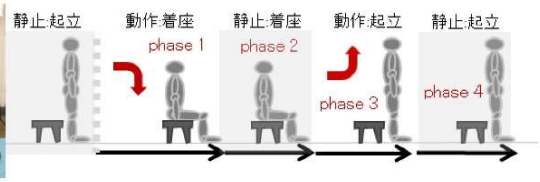
◆ モータ不使用のため小形・軽量・安価に製作可能．

◆ 腕・背中の負担が大きくなると連動して膝も強く補助．

◆ 20-60代までの健常者14名が装着し，起立・着座時の大腿直筋の筋活動を筋電位の%MVC最大値および平均値にて算出し，非装着時と比較した結果，起立時の平均値，着座時の最大値・平均値に効果あり．

◆ 起立時は約20%，着座時は約30%低減し，特に着座時の転倒事故防止への期待ができる．

- When the burden on the arms and back increases, the knees also provide strong support.
- It was worn by 14 healthy participants in their 20s to 60s, and the muscle activity of the rectus femoris muscle during standing and sitting motions was calculated using the maximum and average % MVC of EMG, and compared with when not wearing it, the mean value when standing up, and the maximum and mean values when sitting down were significant.
- The reduction is approximately 20% when standing up and approximately 30% when seated, and is expected to help prevent falls, especially when seated.



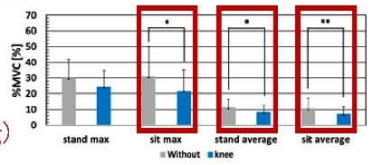
ターゲット市場／製品 Target Areas/Products

◆ 病院・リハビリ施設（患者の日常生活動作補助用）

◆ 介護・工場・農業等各種作業従事者および企業（作業補助用）

◆ 特許出願中，「動作補助作業着」，特願2023-033730

- Hospitals/rehabilitation facilities (for assisting patients with activities of daily living)
- For nursing care, factories, agriculture, etc. workers and companies (for work assistance)
- Applied for a patent



被験者全体での%MVCの比較

被験者全体では
・着座動作時の最大値
・起立動作時の平均値
・着座動作時の平均値
において有意性が確認された．

特に60代の着座平均値の補助効果が大．

研究者名 ：田中英一郎　　所属 ：理工学術院　大学院情報生産システム研究科