

[GraspIt!] [R T sky s t

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/ 2 - & 3 b 9S Y f W 4A d] Burnhootin Q YH] nod S] \\ Worh C \ \bSd\CPPmH m Cm' HGHN b. bell CG EFAW CH bros brinkl d'S HJg JH YGoth Q 16 fc d C E CC Fb FH] mG Sil) Prim d Q HHm_ f H b d H G m Y C d\ S b\ YC Yb\/GCrd\SYf)\\dnS]S\brimW C \ Y\ b\ SS \rdPQrdH m / ^ H \ 4: bmS Y f W AC d]B]PanH \ H 'COubd] HSobn'd Chul H El all abhan \ S ^ f W C d S] \ m $\texttt{d} \; \mathsf{C} \; \mathsf{b} \; \mathcal{N} \mathsf{l} \; \mathsf{frrhC} \; \mathsf{hdn} \;] \; \mathsf{S} \; \mathsf{d} \; \mathsf{d} \; \mathsf{Grr} \mathsf{U} \; \; \mathsf{H} \; \; \mathsf{FS} \; \mathsf{d} \; \mathsf{F} \; \mathsf{nh} \; \mathsf{H} \; \; \mathsf{l} \; \; \mathsf{C} \; \mathsf{Sd} \; \mathsf{d} \; \mathsf{h} \; \mathsf{h} \; \mathsf{d} \; \mathsf{d} \; \mathsf{d} \; \mathsf{nh} \; \mathsf{Q} \; \mathsf{d} \; \mathsf{d} \; \mathsf{nh} \; \mathsf{H} \; \; \mathsf{l} \; \mathsf{G} \; \mathsf{D} \; \mathsf{nh} \; \mathsf{H} \; \mathsf{l} \; \mathsf{G} \; \mathsf{G} \; \mathsf{h} \; \mathsf{h} \; \mathsf{l} \; \mathsf{d} \; \mathsf{d} \; \mathsf{l} \; \mathsf{l}$ 'HCW [6] [S\YdHb]nj\Vb noh Hell [YOmFF] Y^ VbY Q Yb(CCn\nS^f WdCCdbSV] \mm

M K S ? O : TOKU = > d? N (d ? Y d) ? X d U < U . Y S d > d ? Y ? Y ? S Y U . X ? Y ? M N O : S U K > d .@ U % \$1?' V ? = Z ? U \$1 Z ; @ ZU 0 X \Rightarrow \$2 al ZU U V d X ? > K_=J Z? 0 ZU J ? Z X J d ? J d U Y ? d K YVdX U V ? XUNXaKd? S Z; % > cdlN K I S ?_>KdZ JZ dJ ?Jda > X ; S Z d

 $Ja > X; SZScldKSY? XZZldldUY? KdSZlZldl? dla > X; SZ5JdKN?_d? dla > X; SZ5JdKN?_dla > X; SZ5JdKN?_d? dla > X; SZ$

; < U ^ ?_ @l dJ ; ^ ? $\$ \forall U X Z ? $\$ Z>J d^V\dN ; S S ? $\$ \forall \forall Z K UZS\L\forall \forall Z \forall UZS\L\forall \forall Z \forall \forall Z \forall \forall Z \forall \forall \forall Z \forall \forall \forall Z \forall \forall

 $: S > 0 | S \wedge K \times U \times Q ? \times S = N | M | Z : K \times Z K ? Y | d$

B. Our Appr ach

OJ?JdUY?KdSYZ;NNQZ?YSMZ0dW\KXX.??KddSZ?IX;ZUK@sAKd@@?XXcU<U;ZSd>?d'??=\Z?Z>Jd'?dUUZKUSYWoll\XKdSKZKK?NYdLNZ d 2 S 7/dN · S S K · SSI statill S 7 X · ININI Idl X K 7 I 150 27 ds d? = II O V II 27 P 287ds V M d Z U?d; = J Ud @ZdJ ? Q d

""" Od d 2 * d5 / /8 m

A. Hardware Overview

2 * d K Y d @ & N N Y K % Q > SdU K X ld < U; 25 d ld V ? S V N; Z @ U X Q d $O J ? Ed X YYZ \ d < Z ; \& MJ Z \& J d ? J d A Q ; S U K > d X \& YZ \& MJ Z & J d Z ? d = 1 Z d X ? d$ Z J ? Jd U Y ? Kd Y; c6 > c7 U Vd N; S; cd = U N N K Y K U SQ U Jz ZXK? U ZZSdzdd tdX; Y V d > ? ^ ? N U V; ZZ > c0kd " " / O d K I \ X 70d; " Zd kd Y d = Q c7 ; N NSd> d KZ" 81 dt \ X dU X MZ dt? Ed X ? LtU Y ?KdY: dY \ Q ? Z dt dt ? K | K 5 ? dt ? K | J Y, et U \ Z d M | "65 dt ? X Q M @ Dd? = J; S K = Y2 d* d J; Y d d : X ? VIN : S S K S U W W \ Z @ U X = ? Z U W ?W S \ Y ?U W W S \ Q I J ? X U U Z \ S > d > ? I X ? ? V \ @ \ Q X ? ? > U K O S d = N \ > K \ S U \ G \ C ; = J \ G U \ S \ C ; = J \ G U \ S \ C ; = J \ G U \ S \ C ; = J \ G U \ S \ C ; = J \ G U \ S \ C ; = J \ G U \ S \ C \ S \ U \ C \ S \ C Y U Zl J; Z=cU S Z; @ Zl GX = 2 Y Sal al ? CD ?; Y \ X ? & act al J ? Q 5 cK Z J ZcU K Y ct X Q ddU S 6t; = J al; S > cdU S al J ? ZtU X Y US st ddU S al J ? Sal? = M d Y ? S Y U ¥ a Vd; < K N K Ø®aU Xd = ?UdQ V ? S Y; ZV XX Ud X; Q dS d ? Vd Y ? > d ; = J dL U K \$K ZY adX K ^ ? Sa dd < X \ Y J N ? Y dV @d U Z U X Kd Z J d X Q U S K = d Z U=dU S Z XZUJ NI dX; Y V K SQ ILUZ K U "SS; db > K Z K 12 J.S?I ddi; Y V K S@ ILul X = ? eI X K ^; S eI dl; Y dS dU V Z K =?; SN=dU > 7 XI dZ NI N U _\Wd X XY db=dU S Z X U N d = U S Z X U N ZUR? MX bla Zo J.?? AZOd = Z KYN? ?SOdY U M2 \$7 Zd J ? Xd U < W Z 61 > Y; 65 > d ?; = J bl U K \$7 Zd bl ? KdS > K ^ K > \ ON W? &1 ? obt ? obt / X ? obt ? obt / X d; 'K Y@d U X = ? c U S ? Kd S ? X 7 Ø ? N Yd \ X ? O ? \S \$7 kd .77db7 U ? ≥d? S 7 ?U X@xb/d? N ^ K* \$7 Y aK > ? d

@Z?ZXJd?JdUY?KdYdK;YV?ZJd?Jd\Q;SUKX*Ud<UZ;SUKX*Ud<UZ;ZXJd?Jd\Q;VZZ;XXY?db\U=;Z1X*SddJ?*eJ?YZ*Sd?Vd $\label{eq:localization} $J \cup Y ?Y d \cup Z d \cup X ?X d \cup Q ?= d N ? X O Q ?= d N ? X S d ?X d O Q ?= d N ? X S d ?X d O Q ?= d N ? X S d Q S d Q S d O$; S > 21 J ? 2d; < N 27 Ud @d; = K N K Q U ZZ?KdU V SNd; S S K SP ULD X M ; S Y V U X Z K ~ N Yd d S > 21 J ? 1d Z J ? M 61 ? Q U X M AP UD XD Z J ? M M U = ? Y YY? Y = (d); dY d Z J ?JdU Y ? "81 & J J K V & U = ? YZYJ ?&dU < UOZ;da dS ? ? >ZdU;d> L \ YKZZdY dV ? X = ? V Z K.\$J>\$.0dK K J N ? ^=?UNSdZ X LON N ? OK ?; N Z KLOV??dX; Z K S I d < U > aVolU Y ?VolX U V ? X NKa?7d b od = ? S 7 ?NX@?Dd: Y Y MIU Y K 7 K U 18 td d Y a Y Z ? Q-00 6 dS > el \ Y Z U Q K b=?U-SolZ X &UW:oX >:YXO? Zd J ?Qd : K S d _KZJKZSJd?Yd\VVUMXD/dNalUS d : S > dK S Z ? X V U 🛭 J Z ? 21 M X U YX Ld1 Z J J : Z: dd \ Y ? X=d: S d≠ U S Z X 12 : N=d1 d

OJ? oZJKX\%\d< Z; YKN\%\ddUel; XX aZdI? dlUY?ZdU@IJ? ZZ; XI? Zd = Z\; ZUZXdddJ; X>_; X? <; Y@? %-?dW\? \$9 = a.d.d. V U Y K Z K QU IS & d K Y 8 > ZdJ ? Lt\ Q ; S U K X tt < UEZXY Z & Z ? = Z Y ?td O J ? X ? M ? Z _ UXU < U Z & > Y LtS & J ? d2 * d X U < U Z & 3 ; = J d Z J; Z×d? E S? YZ d? d; N M K SM; xZZ J xdS > xZ J? 60 U U YZ N; =? Q? \$X 25 xdU E S I? X \(\neg \text{u}\) S S? = ZZ? \(\neg \text{XZ}\) \\ I \(\neg \text{d}\) N ? Y; \(\neg \text{u}\) dU @ \(\neg \text{d}\) ? Y \(\neg \text{d}\) dV \(\neg \text{d}\) ' ' \(\neg \text{d}\) ' \(\neg \te X?; NZdKQ? IdlSYK>?X KZSPeblJ; SI? ZlUZJJ? NJU=; ZKW @SZdJ? d > XK^?; Sa oddYQ; NNddQUZUX0 Jd*8i? ZloX; YVK S@lddX *K?Ydd d d d Z J ?JdJ Y ?Z dl?_d; N M K \$;IKd ZOd; a ck ? rd> L \ Y Z % >Yd? ±Jd\$ ZdJ ?Sd? _ d Q ? S ZZdU YdK Q \ N ; Z 1.2 2d d2 * d X U < U; Z5 d> &Y N ; SXdJ < UCZ ldl Z K U S Y d U'd VUYKZK"USSZZUC?@1?;SZKQ?J6*8d1',d = USZXUMMN???Wd/d9 : OdJKYYdKQ\N;ZWUXXUd\^K>V?W@1KZJ;cdZUU ZUU ZU MX1;VK>Nad = U S Z X U N XI.K.?Sxtllutl < UZZUbt@l U N N Z J ?cs 4? Y K X 8 5, ctl Z X ; L ? = Z U XVaXctu Z U Z a SV ? 60 ^ ; N \ ; Z-?kct ? X ?; SN Z dJ X K Z J; CS Y ctl S ; N a b Z J d? d > ? ES ? * al \overline{a} J ? \underline{d} ; N M K \$\frac{S}{1}; \alpha Z J; \alpha S > \text{et } U U\Z N \alpha I; = ? Q. ? S \overline{a} Y \overline{a} V ; X ; Z ? \overline{Q} U Z K U\S@ \overline{a} d) ? \overline{a} 2 * \overline{d} X U < U *\Z S \overline{d} 6\tag{0}; K S@ \overline{d} ?; Z \ \overline{M} @ \overline{d} \overline{M} ? S - 4 d X U < U *\Z S \overline{d} 1 \ \overline{M} S *\text{A X U < U *\Z S }\alpha \text{A X U < U *\Z S }\text{A X U N; S > K S=1Lds Z X U N=NU?OXVd? S Y; Z@YV Mad d?\dS?'V? = Z \$ 12 Lds Z; = Z KdY Zd J? db V? S Y K Q \ N; Ø KU U-S, & D Z d; Z KdY kM K S? Q; Z K = ; Sb + N da d @ U X = ? $Y \land dY$? \times d \overline{d} J ? $A \land U \land S \Rightarrow A \land S \land Z := Z \land d$ > a S; Q K =; NYNaaSd= J X U S K \underline{b} R \overline{z} $\underline{d}\overline{d}$ J? d $\overline{2}$ * d X U < U \overline{Z} \underline{J} dK = J d

* S = ?ZdJ ?JdJ Y ?Kd/ZdX; S Y V U XZZJ/ZdJ ?Bdda > X; S ZZ J ?Bdd\ Q; S U K > d; N N U _\YYd? X Z/ Ud; dV V N 2Z d ? K; XN d U X K Z JZQJ/ZdJ ?VdJ a Y K = X N d U Z d X U < UQZ dd ^ ? YZdd ? dU Y ?ZdU ZdJ ? .blu Y ?ZdU ZdJ ? .bla > X ; S-Z ?d@ U XK. ?ZkddS Y ? XZZ.JY?cd ; S > c? ^ ; N \ ; ZZ?.Jd? &d ? Y \ N \(\textcolor{1}{2} \) \$\textcolor{1}{3} \) dZ J ? d2 \(\textcolor{1}{3} \) d X U < U Z K \(\textcolor{1}{3} \) \(\textcolor{1}{3} \) d X J ? d2 \(\textcolor{1}{3} \) d X U < U Z K \(\textcolor{1}{3} \) \(\textcolor{1}{3} \) d X J ? d2 \(\textcolor{1}{3} \) d X J ? d2 \(\textcolor{1}{3} \) d X J ? d2 \(\textcolor{1}{3} \) d X J ? d3 \(\textcolor{1}{3} \) d X J \(\textcolor{1}{3} \) d X J \(\textcolor{1}{3} \) d X J \(\textcol

; S > d U N \ Q VN/d, ; N K Z K ? dK ?d= U XZ >J d _d X K YVZUdY ?Ud@ZdJ ?XdU < U Z d $J: S > dS > dZ J? IdU K S: ZS dIN? YU d@ ZdJ? IdS I? X YO Jd? Y?Sd\ Q < ? X Y d$ = U X X ? Y V U S Ы K & P.d= ZY atl S dP '; Q V N ? Kd I \ X ? d; M J U _ Y; d YZ; < NXdYVUd@; dd 2 * dJ; S > dS ddV K <math>V? dK = JKdYUd < Z; KS? > d $ZJXU\setminus IZJJdKVYXJU=?YY$ d



T.R

C. Motion Planning

@?X?LSZLJ?=57765dU__SJ??-ZdUVdN;SLdJKSZkdL?=ZUZXUSdJYY67d dq nu-du-boonelojbelejyms-Trtqsjo- du_bqs--hyordsn-u-b morn ©bnyn my e-urb -t ou nu-boe-ce ma-boe-o ,ntn+r etn(ytuur/jj-b Z J ?; dX Q dI U ZdJ ? ldX ; Y V K SVI LdIY ?? 'd? = \ Z ZZ .dl?\\dX ? > ? E S \(P.X+ ; \text{dY V} \) db $_{1}$ $_{1}$ $_{2}$ $_{3}$ $_{4}$ $_{5}$ $_{4}$ $: S > td = U \cap V \cap R Y \cap R Y$ LUKSIXdL? = ZU=X; KS2LY; d= JK?^^? ablYKS; ISdd?'KYZC? USX KUUSd VN; SS?" XSlobch X_cUXM_?cld? VNUXKJZ?@clUZKUVSNd; SS?V XKdUVUY? > d D. Motion Execution < a d? X ? S Y U?SZddN [169]. O J K YOdU Z K U VS Nd; S S ?KXY dd; Y ? >UdS d

K--O dS > VIN; SVISE OUSY ZX; OK; SSZKd@ UNK, SV; OU= ? xa OMUY? dZJ?LdUK SSZUM ? YZdo+KC? X?VSUZ KdSZUY@ZloK Q.?_.LdK = JKoY d; NY Ud; d $U < L~? = Z~N~X~20U~;~Q~V~N~?Y~Kd~S~=;~21 = d~a~N~K~S~>~XVKK=V;~TN~20KdU~Z~;~Z~K~U~S~;~N^{L}N^{S}a^{L}d^{Z}X~U~<~U~Z~d~d~X~U~S~;~N^{L}N^{S}a^{L}d^{Z}X~U~<~U~Z~d~d~X~U~S~;~N^{L}N^{S}a^{L}d^{Z}X~U~<~U~Z~d~d~X~U~S~;~N^{L}N^{S}a^{L}d^{Z}X~U~S~;~N^{L}N^{S}a^{L}d^{Z}X~U~S~;~N^{L}N^{S}a^{L}d^{Z}X~U~S~g~d^{L}N~g~d$ = USYK > ?X? > d

_ U X MKdS[d 9] @ U XQdU X ? xd ? Z ; K N, SY xd d? ' V N ; S ; Z K U SdYO td - d O/-GG; Q?dIZUZdJ??dS>?d@@?=*ZUSGdddd6 2 Q; ZXBBdU @<dU \ S > K/ SxZdJ ?=dU U X > K S \UZ@ZdY @Qd / - QG; Q ? d + Q J ? kI > ?; N d
O U ?d^; N \; ZU ? X dK_dU X M_ ?dd; ^ ? xd U S ?K dS K Z ?K'; WN?dX K Q ? SK Z5 Ydd -40.00 o(1)? elu\s>KYSEBIYV? = KZ@Ja?NXUUZ? SZUK.CNYO? Zd ZJ; Z=d S d ? dN N U ? ★ dZ X d2 Y V ? ≧ UZZdJ ? Od / - dG; Q ? d I O J \ Y dA. Experiment in Simulation @UXdd K--OdVN; SS? KXZYd; QVN?ZYJd??dS>?d@@?=\ZUX`@\ddd $Y : Q \lor N K & J d d V \ S > K & Vd = Bd$

HdaO.. + i gn~-ya-qy ns ony~o dows~dnn.ah m7]b-y mj b + i g-~qy jr "SZiJ?VoX?^KUY\Z\?d_?dd;^?\xd?=UX>\??Z>;etNX?;dYV\Y\?n{8/ziK@c ndm yfdulsb+ne;danelumb-oekoyd-udbuksy-zdysh-etayndulsb+n~aaub-~

= USYZX; K; \$Y ZE_Y?dN N,Yd dUZJ? X≑dUSYZX; K 6S ZE?/Y ?2Hel USYZX; K SS ZE V N N KYK U SLX@ LX??⊋ Zd@ Ma ac od ?Xd U < U; ZK dD of U@ U^? ?ZdJ??dS>d ; X ? 'dY ? X > ? E \$ \$ > dX ? d? X & d/? @ '@ NU dM & L ? Q Z 50 K V \ N ; Z K U ? S^Cd? = Z 12/10/20dU ? Zd; X I ? IZXd; Y V K SVIUdY ? 5 16/12/13/18/07 ' Z X Xd? Z K Q K S I d ; d Q U Z K U Z5 Ldd Zd X; S Y V U; Ma VZ Nd; Z @ x X U QU x6 ? Nd N; = 27 x dd ; xdS U Z J ? X x Zd X; L ? = Z; L6X > x60dd; M ? Yd \ X ? xdU Z JZ xd ? ^d ? N U = K SZ xa xdl = = ? N ? X; Z K U S d _ JKN 1910P? VK 16 12bollu XK bUS; 2N; UNScH2 du? Vd; ZJ5 d? d=; SzdN Y N; Nar? d U@? d= JldUK\$ 3 12 70 <u>d</u>KZ JKKSZdM od Q K" 25 72bd K 14 72d? V_?dd V V N 72 1 dl K Y d ZJ?Y=; bol SYZX; KZ 55Y20W?d=Kl@xaYdVK\$@rol@UX>; S@=LP;>4YboldC?X?S_LUKSdL?=ZZUUKZdel@toXQelUSZXUM20del%toXQelUSZXUM20del%toXQelUSZXUM20del%toXel\ZZ?Jd?ZdX;L?=ZUXad

"S 20 J K Y dK -- O dV N; S S ?_X? d#; S 10 V ? = K 20 J aK dW al Q Q ? Z X, Ya dd d W \ ? S = Qa J 20 10 V V ? X t0 > a dX Q Y 50 > 50 ? = N/1 t0 K S 2K W = db0 S Z X U N N ? > d UV?X:Z?Z=dd b QdJY:dd?S?X:Z?X:dL?=Z@UXX&dd?XdU<UZdOUXI? VX? Y 7/5/17/24 dUSYZX; K.SSZ MCdUX>; S=70Y, Y dM/M/M/; =?d; XQ elUSZ; K.ZSJY?dd; N\?UY@?d; = JLdUKS7.2* d*Xad Mr? = USQUdd - ? | K U S Y @ | / - _ d ? X ? Kd S Z X U > \ < 2 el ? d X ? S Y U? SZ odl N d Z X. 5. ? dK X d ? = \ Z Y? \ \ d = J; \ dd Z X ; L ? = Z \ \ \ Z X 2 - 40 \ \ db d Y a Y Z ? \ \ \ 2 ? \ \ 2 | Jd U K S Z d ... Y; Q V N;?Ydd ;=dJ Q Q; S Z dd?d; = J@lU Z U ⇒Xdd S Z X U N N ??dX (dd < \ Y d K. ZlofS?X;Z?55 d d V\NY?ZYUddXK^Z?Jd?d d Q.U.Z.U.XO.Jd?d" d = USYK 10 Z@ZłddłX ? 12°; xX ZY dłdZX; SY@UX Q@DXU 22 dł? dłX KIKUS@dd VUYK Z K; W SS 0Z X UNISI28; X÷dl@lUZ U → Kull SZ X UNISI28; X÷dl@lUZ U → Kull SZ X UNISI28; X ±dl@lUZ U → Kull SZ X M 10 IN ? Kodu K SZ d

< U Z JYdK Q \ N ; Z KSU>SYddJ a Y K =Y; ?NZdZ K S I Y d

OJ? EIXYZ'dV? XKQ?KSYZddJS % dSYdKQ\N; ZKUY SKKYsld? Y = XK < ? > d/_{| 1} 4 0 .00 | 0_0? x?d | K.YOZES? X; Z?=>add K.S.Z.?= Z.K.U.S.d <u>d</u>?d>?= U.Q.V.U.Y.Z. 3 Kd.Y.dY.MK.GS Z.WedJ.\XMd? a.d. VJ;Y?Y d IX;YX/X/S2bdbdY?NoKHKSVodZJ?JdUY?ZoX;SYVUXZKSId

< ? el USYK> ? KK 3/ZelJd? dK--OdVN; SS?0XJ bl Y_d? d> ? ES?ZdJ? dV?X@UXQ:?a;addYKQ\N; Z122>d/dXU< U\2/oKSZLdJ?*dV?S-4 d $O / - d@ X ; Q - 2 \cdot id; Z - \overline{d} J ? U d I X K I KU S@ \overline{d} d J ? V d K V ? a d d Y V ? = K @ a K S I d Y \overline{d} K J Q ? V d N ; Z U X d$ $Q: Z \times kB d_{i} = 0.00 \cdot 0.00 \cdot 0.00 \cdot 0.00 \cdot p \cdot ji \cdot i$; $j' \in K \times kG \setminus X4 \in S \times S = S \times S$ _ ? d N N U Z_d1?Jd; S > Z1 U G1?? N XI b1 Z; Z XI b1 \ S Σ d1 ?Ad ; 'K YKdSZdJ ? d V U Y ? b1 d7 Y J U _ SKdS dK I \ X ? d; OdJ ? b1 U Y ? b1 d8 ZdJ ?Zd; < N ?Z Jd? d O / - d® X; Q ? dI O J ? dX; S Y @ UUX@2ddl ? Od / - d® X; Q ? id Y V ? = K E ? YJdJ Y ? Z dI?Jda > X; S ZS xd dJ J ?XdU < U; XX d' Cd; S \; N NVaXd? > ? E S R' S d Z J ? Vd U Y ? Ud@ ZdJ ? Vd K V ? dK Z JXd? Y V ? ₹ 10 ZdJ ? 2 U X N > bU U X > K S ; Z; 75 ddf V ? S - 4 df S ^ K X U S Q 12 18 72 2d Vd K S 12 df ? d K - - O dV N ; S S ? X d YaYZ?;CSc+6!??>XUd-c1?e!?Z?XQK\$X58Zebld?_dUXMYV; 2 RZd!?Xk1SYK*V@S-4 ZUJ?;dXQ QDUZKU@SkdX@; = JK\$LUZbdJ?JdUY?d Z J X U \ 1; JdM; ? X = ? V Z K; M; Y Z Z; PQ; XdG; S \; NQd?; Y \ X ? Q ? S Z Y d =; S d; Pd; S ? X; Z ? *K Id, X ? d < ; GS > d *d MJ U _ YZd; ?MdK I J; ZXdQ d

= a N K S > X WK K∈ V RY 65daZ J K M Xd; Y V − 67 d ; S Z Zd U;dN N U; Sda dd X; Y V d J a > X; S Z K dd\ X ? dK N N \ Y Z XZ;JZ?%bd% du = ? 10 1∕90 Zdd∪ K ?Y dV ? X K Q ? S Z d Z J ; ZKdYXdU Z ; Z ? X U \ S Z d ? N ; S I Z J kl X ? = Z kl @ 26 kl ? S I Z J kl X ? = Z kl @ 26 kl ? V k V ? Z dJ d K S V k Q \ N ; Z K U S vl ? S d ? S d ? K Q \ N ; Z P U Y Y R K S Y Z ; N N O Z ? S I Z M K V Z C J d K S V K Q \ N ; Z K U S vl ? S d ? S